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More Cancellations

IN a statement issued on April 25, the chairman of the Shipping Board announced that in figuring out the balancing of the merchant fleet it is now found necessary to cancel an additional 2,000,000 tons of steel ships and that the Shipping Board is now considering cancelling all contracts where keels have not actually been laid. As shown in our last issue, previous cancellations of contracts for steel vessels since the signing of the armistice amounted to over 2,000,000 tons, so the latest order reduces the steel shipbuilding programme by over 4,000,000 tons, with the prospect of more cancellations to follow.

With the return of peace conditions, some such revision of the Government shipbuilding programme was not unlooked for, because of the fact that previous unfilled contracts had been let at war prices. In some of the old and established yards the Shipping Board is paying from $195 (40/12/6) to $225 (46/17/6) per ton for cargo steamships and oil tankers, and in some of the new and inexperienced yards as much as $300 (62/10/0) per ton for cargo ships. Future tonnage for the Shipping Board obviously should be built on peace prices rather than on war prices.

Let the Shipyards Take Foreign Contracts

ACTING under the direction of the council, the executive committee of the National Merchant Marine Association recently filed with the United States Shipping Board the following resolution:

"*Resolved*, that in the opinion of the council of the National Merchant Marine Association all American shipyards should be allowed to take orders for the construction of ships for foreign buyers in cases where neither the United States Shipping Board Emergency Fleet Corporation nor domestic buyers are able or willing to furnish the yards with orders to keep the ways occupied; and that a copy of this resolution be transmitted to the United States Shipping Board for action."

In acknowledging receipt of this resolution, the acting secretary of the Shipping Board stated that the present attitude of the Board in the matter of declining to grant permits for construction for foreign account is based on the expressed desires of the President of the United States that no orders for construction of steel ships for foreigners be placed in American yards. The present opinion in this matter is predicated on the yet unsettled condition of world affairs and the present very acute situation with respect to steel tonnage. He concludes by saying that America needs every ship that she now has or that can be built in the near future, and it is deemed wise to conserve for the present the shipbuilding facilities of the United States for the construction of vessels to fly the American flag.

The attitude of the Shipping Board, as expressed in the foregoing, would undoubtedly be heartily approved by all shipbuilders if it were not for the fact Government contracts in many yards, and especially in some of those on the Great Lakes, will soon be completed and ways will be vacant for other work. Domestic buyers are not showing any tendency to place orders in the immediate future, or at least until the policy of operating the merchant marine has been settled. There is the prospect, then, of idle ways in some shipbuilding districts and consequent reduction of trained shipyard forces, a condition that will not tend to conserve American shipbuilding facilities. Shipbuilders realize that the only way in which their organizaton, equipment and trained personnel can be conserved is by keeping the yards fully occupied with work. Under existing conditions, therefore, in cases where neither the Government nor domestic buyers are able or willing to furnish the yards with orders, it would seem the height of folly not to permit such yards to accept orders for foreign account and thereby enable them to keep their plants in full operation at a high state of efficiency against the time when their facilities will be urgently needed for domestic work.

Shipbuilding Prospects

IN the discussion of foreign trade at the Sixth National Foreign Trade Convention recently held in Chicago, ships were admitted to be the controlling factor, and the question of the economical building and operation of ships received a large amount of attention. Speaking from the point of view of a shipbuilder, Homer L. Ferguson, president of the Newport News Shipbuilding & Dry Dock Company, pointed out that under the necessity and stress of war the shipbuilding capacity of the United States has been developed to a point where it can produce ships at a rate in excess of the world's requirements, but that at present American shipbuilding is at the peak of its productive capacity and many shipyards are facing the cessation of work during the current year, as all contracts on hand should be completed during 1920, and many earlier than that.

"The shipyards of the country," said Mr. Ferguson, "have equipment to build vessels in any size up to the largest vessel afloat, and to build the smaller sizes of less than 10,000 tons deadweight in any number required. The men who have been employed in the shipyards will remain if steady employment at good wages is assured. The wages of first-class mechanics engaged in shipbuilding in Great Britain, as recently reported by a representative British shipbuilder, are $20 (4/3/4) to $25 (5/4/2) per week, whereas the wages of similar mechanics in the United States are from $34 (7/1/8) to $40 (8/6/8) per week. American shipbuilders have for many years been urged to build ships as cheaply as they are built in Europe, and many of the foremost industrial authorities in this country have argued that we should compete with them in shipbuilding as we do in many other lines of manufac-

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turing. Repetition or manufacturing processes in a shipyard, however, are exceedingly small, and, except for his ancient aversion to labor-saving tools, the European workman in a shipyard has had the reputation among shipbuilders of doing as much work as an American workman; their greater skill and experience in the minor trades offset to a large extent our use of more modern equipment. American shipowners state that it is very difficult, if not impossible, for them to compete with foreign owners on account of high wages paid and more men required. It is interesting in this connection to note that the wages of seamen constitute probably from 7 to 12 percent of the cost of operation of a vessel, whereas in the building of a vessel in a shipyard from 40 to 50 percent of the total cost is labor."

In discussing the possibilities of the future of the shipbuilding industry, Mr. Ferguson did not consider the outlook particularly bright. A large amount of capital has been invested in building new and enlarging old shipyards, but it has been invested under abnormal conditions and is greatly in excess of the amount which would have been required in normal times. Unless it is written off, plenty of work at good prices will be necessary to keep some of the yards going on acount of the high fixed charges. The recent reduction in the price of steel has not brought it within the range of 1913 prices, and the prices of shipbuilding material and equipment are on a high level. Shipbuilding wages have gone up over 150 percent. The cost of steel vessels per ton, therefore, will be two or three times the pre-war prices until industrial conditions change. On the other hand, Mr. Ferguson pointed out a lesson that should have been learned from the war, and which, if heeded, should be a source of encouragement for shipbuilders. It is that there is not time after war is declared to build the necessary ships, and a large output of ships must be maintained in peace times to keep the shipyards at a high state of efficiency—in other words, we must be prepared.

Shipbuilding in the future, according to Mr. Ferguson, will depend largely upon the kind of merchant marine policy we adopt, as ships can only be sold to those who desire to employ them in remunerative trade. If it is worth while for the United States to expend nearly $4,000,000,000 (£820,000,000) to build a merchant marine in time of war, it is worth something to build one in time of peace, and it is thought by competent observers that $100,000,000 (£20,500,000) spent before the war would possibly have saved $1,000,000,000 (£205,000,000) during the war.

Another possibility in the future of American shipbuilding, which just now is receiving little consideration from the Government, was emphasized by James A. Farrell, president of the United States Steel Corporation and chairman of the National Foreign Trade Council, who stated that our shipyards will soon overcome our domestic and naval requirements, and when these are realized and maintained we should build for the world's markets. American ships were once among the largest of our exports, and, according to Mr. Farrell, there is no reason why they should not be so again. While all shipbuilders may not share Mr. Farrell's optimism in the belief that because we can sell locomotives, freight cars, agricultural machinery and other products of the mechanic arts to all the markets of the world we shall be equally successful in the export of steamships; nevertheless, the amount of tonnage booked by American shipbuilders for foreign account during the early months of the war should not be forgotten, and if the market for vessel tonnage is such that American yards can compete for such business, this advantage should not be denied them.

LETTER TO THE EDITOR

We Have a Standard Type of Ship—Let Us Have a Standard for Building Ships

The hull foreman is the highest officer representing the hull department in charge of a single ship. It is his duty to direct and co-ordinate the work of the several crafts who achieve the results of a completed ship, not, of course, including the machinery. He should be tactful in the handling of men, as well as quick in the determination of the thousand and one problems requiring his decision daily.

He should be competent to analyze the ship and able to visualize the ultimate intended result; to picture in the mind's eye the vital features of the ship stripped of all detail. He is then, and not before, in a position to build. He should be active physically and mentally; physically, because of the need of constant patrol of the ship from bow to stern, from keel to decks, so that he may see and know every detail of the work as it progresses. Woe unto the hull foreman who does not so patrol, for there is scarcely a job but requires just a bit of advice as to its accomplishment. If some job goes wrong, the hull foreman is the man to blame, for he is the all-wise.

The hull foreman may judge his standing with his superiors by the degree of latitude allowed him in the planning of his work. If he be permitted to plan, his standing of importance is high; if he be allowed no initiative in planning, his standing is nil. This rule is an infallible standard in determining the very important question of standing.

The right of the hull foreman to plan the work is of greater importance than merely to gage his standing with his superiors, for it is this right to plan that makes the job worth having, life worth living—that takes into account the human element, the driving quality of pride derived from knowledge of creative instinct, the impulse to a good job well done.

The matter of standardizing the building of ships in the several yards has been given an impetus because of the building of standard ships. This has given opportunity for men inclined to fads and fancies to invent all kinds of schemes and devices for their building. The enthusiasm of a man who has been bitten with the bug of standardization often leads him to great lengths under the "*standard* of standardization" and the so-called standard quickly deteriorates into a mere set of detailed rules which are fastened on the back of the unfortunate hull foreman as was the legendary "Old Man of the Sea" on the back of the unfortunate castaway.

The distinction between a standard for building ships and a set of rules for building ships is of importance only as it affects results; and results are important, since they determine the success or failure of a shipbuilding business. A standard for building ships should be a general plan of erection and fairing that might apply to any ship. It should be stated simply and clearly, stripped of all unnecessary verbiage and detail. It could be stated on a very few pages of typewritten matter. Having determined the standard, it should be adhered to by all hull foremen.

As distinguished from a standard, there is the faddist's set of rules, which are always ironclad, and in their detail usually impossible of performance.

The view of a man of this type is usually limited by the sheets of paper which contain his so-called standard. The building of ships is something more than a diversion. It is essentially a business representing a financial invest-

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ment. The faddist, however, will brook no interference with his foible by such bourgeois matters as business. His only financial interest pertains to salary.

The cost of storing and providing material to permit the building of ships by rule would be enormous, and, indeed, would often be impossible of performance without causing vexatious and expensive delay. But building of ships by rule takes no account of these details nor of the human element involved in the matter of delay. Men delayed in their work are willing to have the condition of delay continued indefinitely. The spirit and habit of work once destroyed are lost.

Let's establish a standard for building ships!

Chester, Pa. WILLIAM F. DELEHANTY.

Prices Yesterday, To-Day and To-Morrow

BY O. P. AUSTIN*

For business, big or little, to prosper or even keep in step with the rapidly changing conditions in the financial world, there must be a clear understanding of the causes which influence the rise and fall of prices. At an industrial conference of the Editorial Conference of the New York Business Publishers' Association, held in New York on April 11, Mr. Austin, the foremost statistician in financial affairs in the United States, if not in the world, clearly analyzed the conditions during the war which caused the world-wide advance in prices. A brief summary of this address is given below, and from this it will be seen that the outlook for a marked or rapid decline in prices, which has been anticipated by many with the ending of the war, does not seem encouraging, at least in the near future.—THE EDITOR.

THE chief causes of the world advance in prices appear to be, in the opinion of the speaker, the inflation of world currency, coupled with the "scarcity demand" and the consequent advance in labor costs. The prospect of material reductions in the near future would depend upon the possibility of the removal or modification of the chief causes of the advance.

CHIEF CAUSES OF ADVANCE IN PRICES

Stated chronologically, the chief causes of the advance seem to have been, first, the "scarcity demand" for war materials, food, clothing, manufactures, manufacturing materials and the labor required for their prompt production, but this was quickly followed by an enormous world inflation, in which paper money with a face value of $36,000,000,000 (£7,380,000,000) was emitted by the printing presses of the countries at war, and the legal tender circulating medium of the world was thus advanced from $15,000,000,000 (£3,080,000,000) in 1913 to over $45,000,000,000 (£9,230,000,000) in 1918, most of the gold formerly in circulation passing into the vaults of the governments and their great banks as a partial basis for this greatly enlarged paper currency.

ENORMOUS INFLATION IN FOUR YEARS

The face value of the paper currency issued in the four years of the war was greater than the value of all the gold and all the silver mined in all the world since the discovery of America. Meantime, the national debts of the world have advanced from $40,000,000,000 (£8,200,000,000) in 1913 to $220,000,000,000 (£45,100,000,000) in 1919, and the annual interest charge from $1,750,000,000 (£359,000,000) to $10,500,000,000 (£2,150,000,000); and this quintupling of governmental promises to pay had also an important bearing upon the world finances, while the fact that bank deposits in the fifteen principal countries of the world grew from about $25,000,000,000 (£5,125,000,000) in 1913 to approximately $73,000,000,000 (£15,000,000,000) in 1919 still further increased the currency supply, especially in countries like the United States, in which the check plays so important a part in current business transactions.

This enormous inflation thus brought about, coupled with the continued "scarcity demand" for food, manufactures, manufacturing material, and labor required for their production, was accompanied by great advances in prices—first in the materials for the war, the advances gradually extending to other articles which their respective producers must exchange for those in which the advance had already occurred, and this made the advance in prices world-wide and applying to all classes of articles, irrespective of their immediate relation to the requirements of the war.

PROBABLE TREND OF FUTURE PRICES

The chief question involved in a consideration of the future of prices is whether there is a prospect of an early removal of the causes of the advance.

The "scarcity demand" still continues in everything except war supplies, and even in that line is not entirely ended, since there are about 15,000,000 men still under arms. The demand for food is as insistent as ever, owing to the disordered state of the population of Central Europe and the impoverished condition of the neglected soils of all that continent, while the factories and empty shelves of all the world are clamoring for new supplies which ran low during the war period.

EARLY REDUCTION IN PRICES UNLIKELY

As to a material reduction in the inflated currency, the prospects for the near future do not seem encouraging in view of the fact that the 1919-20 "budgets" of the principal countries of the world now being made up call for fully four times as much money as those of the year preceding the war, suggesting that the governmental demands in the first peace year after the war will be about $50,000,000,000 (£10,250,000,000), as against about $12,000,000,000 (£2,460,000,000) in 1913, and that the governments which must quadruple their demands upon their taxpayers and prepare for a reduction of their debts will hesitate about reducing the amount of money in circulation.

While there may be a slight downward trend in the general price level and distinct reductions in certain articles, the difficulty in removing the chief causes of the advance suggests that the general reduction in prices in the near future may not be as rapid as had been anticipated.

* Statistician of the National City Bank of New York.

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Problems Confronting American Shipyards*

Analysis of Conditions in the Shipyards—Reasons for the High Cost of Ship Construction—Removal of Existing Inefficiencies Suggested as a Remedy

BY HOLDEN A. EVANS†

THE shipbuilding industry of this country is in a peculiar condition. Before the war we had little oversea merchant shipbuilding. The war brought urgent demand for merchant ships. Large plants were built, both by the Government and private enterprise, and thousands of unskilled men were employed in these plants. To-day this country has greater shipbuilding facilities than any other country. These facilities are largely manned by untrained and half-trained men. The problem before the shipbuilders, therefore, is—what is to be done with these great plants and the army of workmen employed therein?

This must be answered by the Government and the people of this country. At present all of these plants are engaged on Government work. The Government has canceled many contracts and suspended others. The shipbuilder is forbidden to take foreign contracts. The American shipowner will not place any orders. If these shipbuilding plants are to continue in operation, they must be given work by governmental agencies.

Shipbuilding Costs Here and in Great Britain

Before the war cargo ships were built in Great Britain at from $30 to $40 (6/5/0 to 8/6/8) per deadweight ton. At the same time, some cargo ships of similar type were built in this country at from $60 to $70 (12/10/0 to 14/11/8) per deadweight ton. But the American shipbuilder made no money at these prices. The American shipyards were either bankrupt or on the verge of bankruptcy.

To-day contracts are being placed in Great Britain at $100 to $120 (20/16/8 to 25/0/0) per deadweight ton. In this country, under present conditions, it will cost the shipbuilder from $170 to $180 (35/8/4 to 37/10/0) a ton to build the same ship. This is not a pleasant prospect either for the shipbuilder or for the country.

Causes of High Cost of Ships in the United States

The high cost of construction in this country is due to the following:

(1) *High cost of wages.* The wages to-day are double what they were before the war. The wage schedule which was fixed by orders of the Government is approximately double the rates paid in Great Britain.

(2) *The high cost of material.* Before the war steel plates could be bought at $1.10 (4/7), while lately they were $3.25 (13/6½)—approximately three times as much as before the war. All other material costs have greatly increased.

(3) *The inefficiency of a large number of unskilled men taken in the yards,* due to the enormous plant expansion.

(4) *Inefficiency due to rush war methods.* On account of the urgent military need of ships, speed of construction was the only thought. This brought about extravagant methods. One of the results of these rush methods is that the old trained men are not as efficient to-day as they were before the war. It will take some time to bring them back to normal efficient methods.

(5) *The inefficiency due to the rapid increase in wages.* The men do not work as steadily as before the war. There is much more lost time.

This statement of facts will not be disputed by any experienced shipyard manager. What, then, is to be done to continue shipbuilding in this country?

American Shipyard Workers Not the Most Efficient in the World at Present

You will be told by some that the American workman is the most efficient in the world and that this is the answer. The American workman in some trades is the most efficient, but this is not true at the present time in shipbuilding. Ask Homer Ferguson of Newport News, Joe Powell of Bethlehem, Harry Mull of Cramps, Joe Tynan of the Union Iron Works, or any other experienced shipbuilder. They will tell you that shipbuilding is a trade difficult to master. They will tell you that the majority of their skilled men gained their skill and experience in shipyards abroad, and, furthermore, that the shipyards to-day are filled with men who are just beginning to learn.

What, then, is the real answer? It is probable that wages abroad will rise, and that the difference between our wages and theirs will not be so great as it is at present. The cost of material will surely fall, and it seems as if in the near future our material for shipbuilding will be as low as it is abroad. The real answer is: *Remove the various inefficiencies that exist at present and educate and train the workmen.*

Inefficiency Must Be Eliminated

There is no trade or profession which an American cannot master if given opportunity and time. But you can't expect us to learn shipbuilding in a few months in which we have been engaged in the work on a large scale. You can't expect us to compete with managers and workmen who have had years of experience while we have only had our first lesson. It is probable that in the operation of ships on a large scale similar conditions will be found. American operators must be given time to learn before they can be expected to compete with those who have had years' and years' experience.

Shipyards Must Have Ships to Build

We in the shipyards must have work to do—that is, ships to build—and we must have time in which to educate our staff, our foremen and our workmen if you expect us to compete with the world. If we are to maintain a great American-built, American-operated merchant marine, the American people must in some way or another pay for the excess cost while we are learning to build and learning to operate. In no other way will we ever get it.

The American people are thoroughly convinced of the absolute necessity for our own merchant marine, and we are going to have it. But the facts must be learned and the case presented fairly and squarely to the people. They will be willing to pay the price, provided it is a fair price.

But don't be misled, don't make any mistake—the price must be paid if we are really going to get a great mer-

* From an address delivered at the National Marine League dinner, Hotel Commodore, New York, March 27.

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chant marine. We have plants and machinery superior to the equipment abroad; we have aggressive and efficient shipyard managers; we have ingenious and intelligent workmen. What a magnificent foundation! But we must have more than the foundation; we must build on this foundation. Just as in golf—just as in any business or profession—you must have practice if you are to compete—if you are to excel.

So it is in shipbuilding. Give the shipyards and the American workmen in those shipyards a chance—a fair trial. Give the well-equipped plants ships to build, allowing a fair margin of profit. Let our managers and workmen have an opportunity to learn and progress. If you will do this, the extra cost will be well expended—I promise you that—the shipbuilding industry will nobly respond, and in a few years the United States will be the greatest and most efficient shipbuilding country of the world.

Problems of the American Merchant Marine

BY LAWRENCE B. CHAPMAN

To establish the American merchant marine upon a permanent basis, it is necessary to take advantage of the possibilities for American ships to compete with those of other nations. In this article the author, who is a trained naval architect with experience both in the education and training of naval architects and in the practice of naval architecture, summarizes the possibility of the future of the American merchant marine in one word—efficiency. The discussion of the subject shows how material advances can be made in the competitive race for supremacy by efficiency in design, efficiency in construction and efficiency in the operation of ships. When it is realized that both the shipbuilding and shipping industries in America are in their infancy, it is apparent that their development must be carried out along sane lines if their future is to be assured. No one will dispute the author's statement that the possibilities for improvement by efficient designing, construction and operation of ships are prodigious and that herein, other things being equal, lies our opportunity. At a time when established methods and practices must be abandoned to make way for new, there is no better slogan to adopt than the watchword proposed by the author—efficiency.—THE EDITOR.

ONE hears so much at the present time about the probabilities and feasibilities of the American merchant marine that it is worth while to analyze the situation and see what the possibilities are for American ships to compete with those of other nations. We realize that building costs are higher here than abroad, that the American seaman is paid higher wages, and that as a nation we are not as well educated in shipping as many of the competing nations. But do these facts in themselves rule us out of competition and leave America's only hope for a merchant marine in government ownership?

FUTURE OF AMERICAN MERCHANT MARINE LIES IN EFFICIENCY

America's hope lies not in government ownership or ship subsidy, but in efficiency—efficiency in design, efficiency in construction and efficiency in operation. It may be that in the end a government subsidy in some form may be needed; but let this be a secondary or temporary help, not the main support as too many are wont to advocate.

The possibilities for improvement by efficient designing, construction and operation are prodigious; and herein lies our opportunity. The problem of ship design is perhaps the most important of the three, for construction and operation depend to a considerable degree on the design. In the past the design has too often been merely a technical problem of dimensions, deadweight capacity, and power to meet the requirements of the owner. A fair amount of attention has been given in the design to ease and cheapness of construction, but little or no attention to the economics of operation.

PROPER TRAINING OF NAVAL ARCHITECTS THE FIRST NEED

The first need in this field is that the young men who are to take charge in the future be properly trained and educated. The training of naval architects to meet these new conditions demands a radical change in our university courses. The student's contact with the shipbuilding and shipping industries must begin at the very outset of his training, and the practical, economical and theoretical work must all be carried on at the same time. The requirements of a course of training in naval architecture were treated in an article which I contributed to the April issue of this magazine and need not be taken up in this article.

The shipbuilding yards and steamship companies should make it their duty to assist the students in their studies, by giving them summer work and co-operating with the universities, perhaps offering scholarships or paying part tuition for worthy men in their employ. The establishment of apprentice schools similar to some of the British schools might also be of great benefit.

SCIENTIFIC RESEARCH SHOULD BE ENCOURAGED

Research in naval architecture and marine engineering should be seriously taken up and every possible problem bearing on design, construction and operation threshed out. The British government has recently appointed a committee and appropriated money for this purpose.

Again, in the matter of research, the shipyards and steamship companies should give liberal assistance. It is for them not only an opportunity but also a responsibility. Research professors and students in the universities have the leisure time and the aptitude to investigate many difficult and intricate problems bearing on merchant ship design, construction and operation. That they have in the past given valuable data to the industry, the proceedings of the various technical societies will affirm. Such work as this must be supported by fellowships, scholarships and endowments. The British Government has supported work of this nature in some degree, the recent Bulkhead Committee being an example. Might not our Government contribute to work of this nature as one

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of the ways of helping the new American merchant marine?

This research work should be mainly along new and original lines. The fields of model experiments, stability and strength have already been fairly well covered. Experiments with full-sized ships and self-propelled models; investigation of the best form for speed at sea as compared with smooth water; propulsive coefficients; frictional resistance of actual ships; and cargo handling appliances are a few of the problems that suggest themselves.

The naval architect will meet many problems of this nature that his exacting duties will leave little time to solve; yet to keep our merchant fleet at the forefront, these problems must be solved and the method just mentioned offers excellent opportunities. There will be countless problems, especially of an economic nature, that will hold the attention of the naval architect. It will be his duty to keep the building cost as low as possible, to distribute the material to get the maximum strength on the minimum steel weight, to keep the cubic space allowed for deadweight as large as possible, to study the ship as a unit and determine the dimensions, coefficients and speed for the most economical performance in service. The naval architect's duties as a representative of a steamship company will be dwelt upon later in more detail.

Efficiency of Ships in Operation Neglected

As already mentioned, very little attention has been given to the consideration of the design for the most efficient operation in service. The reason for this is because the owners have habitually gone to the shipyards for their designs instead of working them up themselves. The function of the naval architect of the future should be the connecting link between the owner and builder. He should either be on the owner's staff or a consulting naval architect intermediate between the builder and the owner. It should be his duty to adjust the commercial and scientific properties which are often in conflict with one another.

The builder in working up a design to meet stated conditions of the owner has given his main attention to costs, hull and machinery details and construction, ignoring too often the fact that the ship is a unit which has to meet certain economic conditions. This is but natural, for his interests lie in these fields and the owner has not forced the other problem on his attention; if he had, it is doubtful if the builder would have had the necessary experience and data at his command. For this reason the steamship company should prepare its own designs and submit them to the builders. The larger companies could have their own designing staffs, while the smaller companies need only have a retained or consulting naval architect to care for their interests.

Ships Should Be Designed By Owners' Naval Architect

The steamship companies' naval architects should make a thorough study and analysis of the problem in hand and determine the proper size, proportions, coefficients, speed, cargo handling arrangements for maximum efficiency; and propelling machinery and propeller revolutions per minute, etc., for the required service. He will have all the experience, operating data and costs of the steamship company at his command; he can observe the performance of the ships in service, study the loading and discharging problems, make careful observations of the ships while docking and repairing, and have a thorough first-hand knowledge of the operation and economy of the propelling machinery and auxiliaries of the ships of the company's fleet. The design prepared by a naval architect with this information to guide him will fulfill much better the owner's needs and produce the proper ship to give the most economical performance in service. An excellent paper by John Anderson before the Institution of Naval Architects, 1918, touches on some of the economical aspects of this problem.

A ship designed in this way will be planned for the best performance and minimum power in service, not for the builders' trials in smooth water. The owner's naval architect can settle the horsepower, revolutions per minute and propeller dimensions for the speed required, and the builder need only guarantee boiler performance and the horsepower and steam consumption of his engines.

Details Left to the Builder

Many of the details of construction, fittings, equipment, etc., can be left to the builder, or determined by consultation between the builder and owner's representative. With this arrangement the building yards would be relieved of a large part of the expense of working up designs—work which is duplicated for every proposal by nearly every yard in the country. They would be relieved of exacting speed trials and guarantees, all of which add to the cost of the ship. In short, the steamship company would work up the design and submit it to the builders instead of ten or twelve yards each working up their own design and submitting it to the owner.

The propelling machinery with its auxiliaries should receive as much attention as that given to the hull. The owner's naval architect should determine the type of machinery, boilers and desired fuel and steam consumption from his knowledge of the ships in service. Here, again, the machinery will be chosen and designed for service at sea and not for a trial course. The owners should carefully consider whether coal or fuel oil should be used, whether steam or Diesel engines, whether Scotch or water-tube boilers, and whether geared turbines, electric drive or reciprocating engines should be installed. Each of these items must be carefully considered, and saving in space and weight must be balanced against cost and fuel economy. The details of the propelling machinery should be left entirely to the shipyard or engine works.

Saving of Heat Units the Watchword in Laying-Out Machinery

The saving of every possible British thermal unit should be the watchword in the layout of the machinery. A careful and searching study must be given to economizers, feed heaters, superheaters, high steam pressures and high vacua. Economy in British thermal units must be balanced against first cost and depreciation. Each piece of auxiliary machinery should receive its share of attention. Exacting guarantees should not be required for steam consumption of auxiliaries, as this increases the first cost. The exhaust steam is generally used for feed heating, and any economical, and hence expensive, auxiliary is apt to be a loss rather than a gain. Keep in mind that guarantees and rigid inspection increase the cost of auxiliaries. Piping layouts should be simplified as much as possible and all fittings and valves standardized. The owners will have a large experience to draw on for operating costs, economy and repairs of propelling machinery, and the builder will have a wide knowledge of details, initial costs and engineering practice at his command. A complete getting together of the two interests should reduce the costs both of construction and operation.

Guarantees

Another point worthy of discussion is the question of guarantees. In the above arrangement where the ship-

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builder assumes practically no guarantee except workmanship, power, and steam and fuel consumptions of main engines, it is not so much importance. There will always be cases, however, where the shipbuilding company assumes the whole responsibility for the finished boat and guarantees speed, coal consumption, G. M., cruising radius, turning circle, etc. In all cases, as previously pointed out, guarantees of any nature increase the initial cost, for the builder must protect himself against the failure to meet these guarantees.

It has been the practice of some firms in the past to exceed their guarantees, especially speed, by a considerable margin and then to acclaim the deed as a remarkably fine piece of engineering. To exceed a guarantee by any but a comfortable margin is as bad engineering, perhaps even worse, as to fall down on a guarantee. Let us consider an example: Suppose a firm contracts for a ship to make 15 knots, and on trial a speed of 16 knots is attained. This is an excess of 6⅔ percent in speed, but an excess of 20 to 25 percent in power. Either the prospective owner is paying for this additional power in a high initial cost or the shipbuilding company is paying for it out of its profits. Unless the ship is of an unusual type or the machinery of a new kind, 10 percent margin in power ought be ample. The owner has ordered a 15-knot ship and believes that he is paying for such, and, while 16 knots may be very acceptable, we should not lose sight of the fact that someone must pay for the extra power. Of course, when bonuses are given for additional speed, the case is different; but the practice which has been followed in the past, especially in naval vessels, of showing a speed of several knots better than the guarantee is not good engineering. The same reasoning applies to all other guarantees and contract requirements. A technical staff trained and educated in the proper manner should keep problems of this nature well in hand and reduce the initial cost.

Efficiency in the Shipyards

Let us now turn our attention to the second problem—the shipbuilding industry. Anyone at all familiar with shipyards the world over must realize the great inefficiency existing. It is with diffidence that I add even a few remarks on this subject. The task of improving conditions is at once so hopeless and yet so rich in possibilities on paper that I am tempted, however, to add a few remarks. If conditions in our yards can be improved and the first cost reduced, serious attention should be given to a study of the problems involved. A shipyard, with shops and building slips covering acres of ground, offers a far different problem than a shop all under one roof, or even a plant such as the Winchester Arms Company, which covers a whole city block. In the former case different types of ships are constantly building, while in the latter practically all processes are along standardized lines. Yet a system of scientific management following more nearly the Taylor system would be a great improvement over many of those existing. Much of the work done in the shops could follow Taylor's system very closely. A route chart of the yard could be made as in the Taylor system and careful study made of routing material to shops and ships. An efficient messenger and information service with 15 or 30 minutes' service might be installed to advantage.

An exact system of scientific management is almost impossible to install on hulls under construction on account of the nature of the work. Some electric system, however, might be devised for calling and keeping in touch with the foremen which would save needless chasing around the yard. Some automatic system that will give the office a continuous check on a ship might also be devised. As an example, frequently a number of fitters are held upon a piece of work because a driller cannot be found. This is but an example; there are countless others like it that the above system would eradicate.

The problem of soldiering and loafing of labor and the needless walking around of the workingmen needs the most serious attention. Better and closer supervision would solve this, but this increases the overhead, which has already gone too far. Overhead, clerks and inspectors must be cut down. There is too much tendency already of paying one man to watch another. The workman must assume more responsibility and report on his own work. Some electric system of keeping a continuous record of the work would solve this problem and save much useless walking to and fro. In a word, the present spirit that pervades the yards must be in some manner extirpated—how, I will not attempt to suggest.

Standardization

Standardization must be introduced—not necessarily standardization of all ships, but the building of ships in groups so that production methods can be used. When ships are built thus in groups, models can often be used and much unnecessary time saved walking to and from shops, climbing aboard ships, etc. Parts, fittings and equipment must be standardized and many times purchased outside the yard. Anything that will save drawing, patterns, casting, forging and clerical work with all its entailed overhead must be eliminated as far as possible.

Anti-fatigue surveys might be made and every possible help given to relieve unnecessary strain on the workmen. F. B. Gilbreth has given a careful study of fatigue problems and has in many instances increased production to a marked degree by relieving the strains of fatigue.

Motion study with a moving picture camera such as Mr. Gilbreth has used will almost always result in an increase in production. This need not be used necessarily with the object of setting the time for a job as in the Taylor system, but more especially to cut down unnecessary motion, etc.

The co-operation of the workmen should be sought after and some sort of suggestion system with suggestion boxes installed and prizes or other rewards given for all suggestions adopted. Truly the problem is prodigious, but the reduction in cost of production offers one of our greatest opportunities for building up a merchant marine.

Ship Operation

The problems of shipping and ship operation are even more important than the two just discussed—designing and building. I have already pointed out some of the aspects of operation and the necessity of the owner's naval architect studying these problems. An analysis of this problem by dividing the costs of operation into several groups will be of great benefit. Anderson in his paper before the Institution of Naval Architects in 1918 has given some interesting pre-war costs of operating British ships. For a lack of reliable data on American ships I will use his figures as a basis for discussion.

The first factor on which we should direct our attention is the wages and provisions for the crew. We hear so much talk and there are so many articles in the press regarding the high operating costs of American ships due to the LaFollette Seaman's Act that it will be worth while to clear up this point at the start. The amount expended for wages and food for the crew varies from 7½ to 13½ percent of the operating cost of the ship. If we assume that our expenses are double those of the British—certainly a maximum figure—this item of wages and

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provisions averages about 18 percent of the total operating expense. Surely the American public is arguing along wrong lines when they concede that an item which is of an order of 10 to 18 percent of the operating expenses is the prohibitory factor of our merchant marine. Granted that we must accept a higher rate for wages and provisions for crew, there still exists the possibility of shaving down the remaining 80 to 90 percent of the operating expenses.

The following table, made up from data in Anderson's paper, gives the operating expenses for an 11-knot ship with a radius of 4,000 miles. The figures given in the paper show that the ship earns a profit of 20 percent per annum with a freight rate of $2.15 (8/11½) per ton (pre-war conditions).

Length	490 feet
Deadweight	13,126 tons

	Percent
Coal	16.5
Wages and provisions	9.0
Depreciation, insurance and repair	28.0
Brokerage and management	12.5
Loading and discharging	25.0
Tonnage dues	9.5

This table shows a distribution of the operating expenses, and a study of it will show where to begin cutting expenses.

Where Operating Expenses May Be Reduced

Items (3) and (4) are the largest and are more or less beyond our control. Depreciation and insurance have a direct relation to the initial cost, which has been covered earlier in the article. Repairs can ordinarily be kept to a minimum by careful designing and regular inspection.

Item (2)—wages and provisions—is a small item, and, as already stated, will be accepted. If the American scale of wages and standard of food is double that of Britain's, this item becomes 18 percent instead of 9 percent. If our laws require a higher paid and more intelligent crew, can we not expect more efficient handling and better upkeep of the ship than our competitors with poorer paid crews?

Tonnage dues (item 6) are also fixed, but can be kept in hand by attention to tonnage rules when designing. They are of small magnitude, however, and equal for ships of all nations.

Loading and discharging is one of the largest factors in operating expenses. Any reduction in this item, brought about by more expedient and efficient handling of the cargo, not only reduces the large cost of operation (25 percent of total operating expenses) but also allows a quicker "turn around" in port, which means an increased earning capacity for the ship. Under the present conditions a vessel similar to the one under consideration spends about 40 percent of the year in port either loading, discharging or docking.

Loading and Discharging of Vessels Now Costly

Is it not in this field that there is the richest opportunity to cut expenses? Would we not do well to bend all our energies to a study of loading and discharging of cargo to reduce this high percentage of expenses and reduce the time of detention in port? Let us equip the storage sheds with overhead traveling cranes and the wharves with jibs for loading and unloading. Let us load as much freight as possible directly from the cars to the ship or from ship to cars. If goods are to be custom-inspected, double handling may be necessary; here is another opportunity for the national government to help by giving the matter of custom inspection a thorough study so that freight handling will not be delayed on this account.

The layout of the ship's cargo-handling arrangements—booms, winches and hatches—needs the most careful study. As already pointed out, a naval architect employed by a steamship company will give this problem more careful and intimate attention than a shipbuilding company. This layout forms one of the most essential features of the design, and in the past has been given too little attention.

The remaining item in the table is coal (16 percent). The reduction of this item offers abundant and interesting possibilities. More efficient machinery can be installed, such as geared turbines and electric drive, which, on the one hand, will decrease the steam consumption by giving more ideal conditions for the prime mover and, on the other hand, increase the propeller efficiency by giving lower revolutions per minute.

Possibilities of Saving Fuel

Scotch boilers can be replaced by watertube boilers and hand firing replaced by automatic stokers. Both of these will increase the cargo deadweight carried, the former by lighter boiler weights and the latter by the smaller amount of coal carried due to the less fuel consumption per horsepower (better boiler efficiency). The larger the percent of displacement the boiler weight is, the more gain there is in using watertube boilers.

The objection has often been brought forward, and recently with good cause, that watertube boilers are impractical on merchant ships, because they require a much better trained personnel. In the past months of great stress this has been true. In the future, highly trained firemen should be available and this objection removed. If the much discussed Seaman's Act requires us to pay high wages, why not insist on the best type of men—men capable of handling watertube boilers? As I have already pointed out, there are a great many ways open whereby we can make this Act a help rather than the hindrance that we have tried to believe it.

Superheat and Other Means for Increasing Efficiency

Superheat, higher steam pressures, high vacua, better feed heaters, economizers, preheating of the air to the ash pits—all offer great possibilities for increase in efficiency. These should all be carefully investigated, not only from the point of view of steam engineering but also from the standpoint of cost, operating expense, depreciation, etc.

High vacua have been given careful consideration; but the question of increase in initial steam pressure has not received the attention it deserves. This gain is not merely the increase in initial heat contents, but a decrease in entropy, resulting in a lower heat contents of the steam entering the condenser. Thus the gain is greater than is at first apparent. Where turbines with velocity wheels in the first stage are used the pressure can be quickly reduced to that formerly used in reaction blading.

Power Plant Refinements

An examination of power plants ashore will suggest refinements never introduced on shipboard; yet these refinements have been the means of greatly improving the power plant efficiency. Some of these, as mechanical stokers and economizers, have already been referred to. Recording CO_2 meters, feed water meters, draft gages, recording steam gages, thermometers and records of coal used not only assist the engineering force to do better work but they also spur them on to competition, since they know that all the records are open to the superintending engineer of the steamship company. Often many of these

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are not advisable, but as a rule many of them can be adopted with great profit.

Strict attention always should be given to the performance of the plant. Soot removers should be installed, leaky condensers remedied, and all the machinery kept to the highest point of efficiency. Boiler and engine tests should be made from time to time as a check on the performance of the ship. Frequently these can be carried out during regular service runs by students of naval architecture or marine engineering with mutual benefit to owner and student.

Coal Versus Oil

Another point that will present itself early in the study of engineering economics is the problem of coal versus fuel oil. Contrasting coal (hand fired) against fuel oil, the saving in favor of the oil is, roughly, 55 percent—30 percent on account of higher heat contents and 20 percent on account of better boiler efficiency caused by better combustion and smaller excess of air. Expressed in terms of pounds of fuel per horsepower per hour, under the best conditions oil will run about 0.87 pound and coal 1.35 pounds per horsepower hour. If we look further into the problem and compare the cost of coal against fuel oil, we find that the oil costs from two to three times as much as coal (Atlantic coast). Combining this fact with the reduction in fuel consumption, it appears that the cost of operating on oil is nearly double that of coal. There are, however, other factors to be considered. The boiler upkeep and the fireroom force are less with oil than coal; the cost and time of bunkering are greatly reduced for oil, and ashes and ash-handling apparatus are absent with oil-fired boilers.

The important saving, however, is in the reduction in weight of fuel carried and the gain in cargo space. The reduction of 55 percent in fuel consumption means an increase in cargo deadweight or a longer radius on the same amount of fuel. Fuel oil can be carried in the double bottoms and other places unsuitable for coal or cargo and a large amount of cargo space gained. The case of an actual ship should be worked out in order to see just what the gain would be. In the final analysis, when all the above factors are given proper weight, fuel oil will generally be a decided advantage, provided, of course, that the vessel's route is such that oil is available.

Mechanical stokers are in operation to-day that show nearly the same boiler efficiency as oil; so this fact should be given weight in any just comparison and the above difference will be somewhat reduced.

Possibilities of the Diesel Engine

The possibility of Diesel engines needs careful attention and this type of machinery installed where feasible. At present the horsepower available is the real limiting factor in most cases. Engines up to 3,000 horsepower and slightly larger are now available; so this allows at the present day an installation of 6,500 horsepower with twin screws.

The fuel used by Diesel engines (.45 pound per shaft horsepower) is, roughly, one-third to one-quarter that used by a reciprocating engine with hand-fired Scotch boilers. The remarks on fuel oil versus coal given above hold equally well here, except the reduction in fuel consumption and consequent increase in deadweight will be double that of the all-steam comparison. There is also the elimination of the fireroom force with Diesel engines.

Diesel-electric propulsion also offers fine possibilities. This method of drive gives a reduction in propeller revolutions per minute and allows two engines and one propeller, if desired, thus giving a possible 6,500-horsepower on one shaft. Electric deck machinery can also be used.

The study of trade routes and markets are important problems needing earnest attention, but are beyond the scope of this paper.

It would appear from the above analysis that the future of the American merchant marine is more or less in our own hands. To compete successfully with other nations on the seas, many of our established methods and practices must be abandoned, our shipyards must be given a thorough house-cleaning, and efficiency must be the watchword in designing, building and operating. The economies of ship operation—entirely neglected in the past—must be given serious attention in the design, so that the ship will be of the proper size and speed to earn the largest percentage of profit on the smallest initial cost; loading and discharging facilities must be improved to cut down expenses and decrease the ship's detention in port, and the propelling machinery must be brought up to the highest point of efficiency, both in design and operation.

Oil Tanker F. Q. Barstow Repaired in 64 Days

ON November 22, 1918, when a disastrous fire swept over the Standard Oil Company's piers at Canton, Baltimore, the company's tanker *F. Q. Barstow* was very badly damaged. This tanker has a gross tonnage of 10,290 tons and is 500 feet long and 68 feet 2 inches beam. At the time of the fire the ship was tied up at the Canton pier, and it was impossible to take her away from the dock until practically the whole interior was wrecked.

Bids were immediately solicited by the Standard Oil Company from the Eastern repair yards. A New York concern agreed to do the work in 155 days, a local Baltimore concern in 130 days, and the Baltimore Dry Docks & Ship Building Company, Baltimore, Md., in 65 days. Contract was placed at once with the latter firm, and the vessel was moved over to the south plant of the company.

On December 9, 1918, the work was started on the *Barstow*. Repairs were absolutely completed on the whole vessel at 4 P. M., February 10, 1919, and the vessel left the plant of the Baltimore Dry Docks at 11:30 on the following day to be provisioned and supplied preparatory to leaving for Tampico and Port Arthur, Tex. The vessel had been at the plant only 64 days, and during this time two holidays intervened on which no work could be done, and eight days were lost on account of inclement weather, so that the work was actually done in 54 working days.

The repair work on the vessel comprised the replacing of 102 damaged shell plates and 126 damaged deck plates, as well as the necessary stringers, brackets and longitudinal and transverse frames. In addition, it was necessary to provide new fittings in the captain's quarters, the officers' quarters forward, the saloon, wireless quarters, the pilot house and forward quarters. New quarters were also constructed for the crew amidships.

Activities of the Steamboat Inspection Service.—During the year 1918 the United States Steamboat Inspection Service inspected and certificated 7,015 vessels, with a total gross tonnage of 8,464,696, of which 6,788 were domestic vessels, with a total gross tonnage of 6,846,356, and 227 were foreign passenger steam vessels, with a total gross tonnage of 1,618,340. Of the domestic vessels, there were 5,532 steam vessels, 695 motor vessels, 18 passenger barges, and 543 sea-going barges. There was an increase of 31 in the total number of vessels inspected, and an increase of 1,215,107 in the total gross tonnage of vessels inspected, as compared with the previous fiscal year.

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UNITED STATES BATTLESHIP NEW MEXICO

The First Battleship in the World to Be Equipped With Electrical Propelling Machinery

Fig. 1.—The *New Mexico* is 624 Feet Long Over All, 97 Feet 4½ Inches Extreme Beam, and at a Draft of 30 Feet Displaces 32,000 Tons

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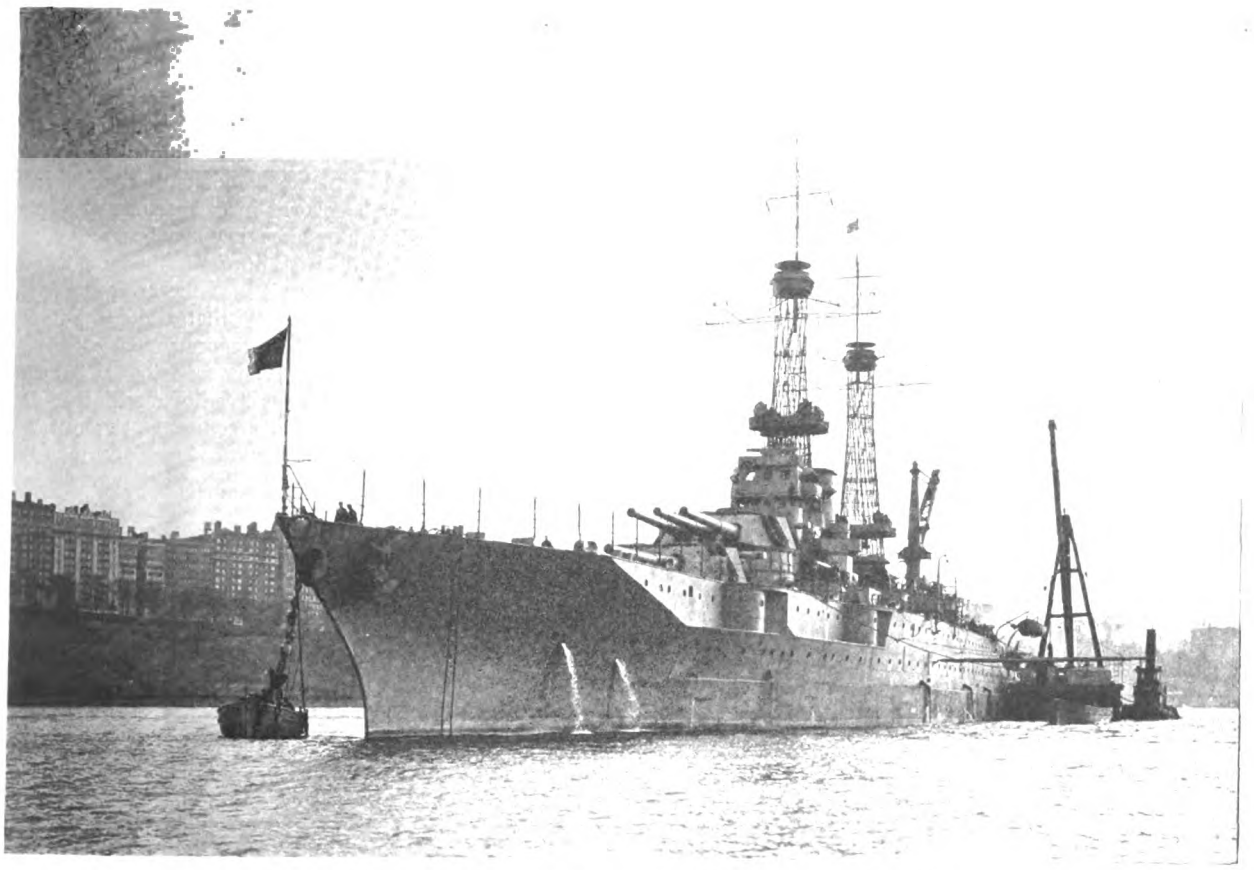

Fig. 2.—The *New Mexico* at Anchor in the Hudson River at New York

United States Battleship New Mexico

First Capital Ship in Any Navy to Be Fitted with Electric Drive—Description of Propelling Machinery—Trial Data

BY COMMANDER S. M. ROBINSON, U. S. N.

THE completion of the *New Mexico's* trials marked the successful end of a campaign that was begun more than ten years ago by W. L. R. Emmet, of the General Electric Company. At that time Mr. Emmet, in his advocacy of electric propulsion, was in the position of an apostle with a small following, but in the Bureau of Steam Engineering of the Navy Department he found an organization that was progressive enough to undertake the development of a system that offered such great advantages. He was able, therefore, to secure a contract with the Navy Department for the machinery of the collier *Jupiter*, and thus the experiment of electric propulsion was begun. It was successful from the start, and after a year's trial Rear-Admiral R. S. Griffin, the chief of the Bureau of Steam Engineering, shouldered the responsibility of putting it into capital ships, the *New Mexico* being the first.

Before proceeding to a description of the *New Mexico* and her machinery, the advantages of electric drive will be briefly touched upon. Inasmuch as the machinery plant of every type of ship is a complete problem in itself, the comparison of electric drive and other types of propulsion will be confined to that type of ship for which the United States Navy has adopted it—the capital ship. Owing to the large horsepowers that are used in this type of ship, the choice of a method of propulsion is limited to direct-connected turbines, geared turbines and electric propulsion, so that comparison will be made between these three.

The first of these suffers in all points as compared with the other two, and therefore may be discarded at once, provided either of the other methods is sufficiently reliable to make it satisfactory for naval purposes; therefore, the comparison may be further restricted to geared turbines and electric drive.

Comparison of Electric and Geared Turbine Drive

The comparison between the two types of installation should be made in regard to the following points:

(1) Reliability.
(2) Necessary weight and space.
(3) Steam consumption.
(4) Flexibility as regards installation.

Of course, no type of machinery can be given any consideration which is not absolutely satisfactory in regard to the first point—reliability. It is believed that the experience of the Navy Department with electric propulsion on the *Jupiter* has demonstrated its reliability beyond any reasonable doubt. That ship has been in commission over five years and has been in continuous service with practically no electrical troubles. The trials of the *New Mexico*, just completed, indicate that she should duplicate the *Jupiter* in this respect.

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There are several reasons why electric propelling equipment should be more reliable than other types of machinery. The weakest member of electric propelling machinery is in the same place that it is with other types of propulsion—that is to say, in the steam turbine itself. However, owing to the fact that this turbine has no backing turbine incorporated with it and therefore always runs in the same direction, it should be much less liable to damage than those turbines which are directly connected or geared to the propeller shafts. Also, it should be much less liable to damage from mis-alinement. In many cases with direct-connected or geared turbines, the wrecking of one turbine will put two shafts out of commission; with electric machinery this is never the case, as each shaft can be entirely isolated from the others by opening the disconnecting switch of the motor on that shaft. Also, in case of damage to a turbine, with the straight steam drive, the work on the remaining shafts is very much increased owing to the drag of the idle propellers; with the electric drive, failure of a turbine does not in any manner affect the method of propulsion, as all screws will still be in use.

This is quite an important point, not only because of the added resistance of the dragging screw, which may be as high as 15 percent of the total effective horsepower required to drive the ship, but also because the maneuvering qualities of the ship are seriously affected. This is especially true if the damage to the turbine is such that its shaft cannot be allowed to revolve. In this case, the maximum speed of the ship will be very low, as it will not be possible to lock the damaged shaft against high speeds of the ship.

Another less important advantage of the electrically propelled ship is its flexibility of operation, which allows the operating engineer quickly to shift from one turbine to the other. This advantage is brought out most strongly in the case of a ship entering or leaving harbor where one of the main condensers may be temporarily plugged with mud or other foreign matter requiring a temporary shutdown of that turbine.

Weight and Space

In regard to the second point—the question of weight and space—there is little to choose between the electric drive and the geared drive, but both are very superior to the direct-connected turbine in this respect. In the case of the *New Mexico*, there was a saving of over 200 tons in machinery weights as compared with her sister ships, which were equipped with direct-drive turbines and geared cruising turbines. It is probable that the geared drive has some advantage over the electric drive in this respect, but the difference is not great enough to be of much importance.

In regard to the third point, or the steam economy, the geared drive will probably have a maximum of 5 percent advantage at full power over the electric drive. As the speed is lowered, this advantage very quickly disappears and at most of the operating speeds of the ship the electric drive will be better in this respect. At the cruising speeds of 15 knots and below, the advantage of the electric drive in this respect will be very marked indeed. Of course, this advantage of electric drive at the lower speeds can be offset by installing a separate set of geared turbines for cruising purposes, but in this case any advantage of the geared drive as regards weight will then disappear and the operation of the machinery will become very much more complicated.

Flexibility of Installation

In discussing the fourth point—installation—I will touch upon the main and compelling reason for the adoption of electric drive for capital ships. The advantages in this respect are so great that they cannot be ignored. Any prime mover which must be attached to the propelling shaft, as is the case with any type of machinery except electrical, is at an enormous disadvantage in this respect. The main turbo-generators for electric propulsion may be placed in any part of the ship that is most suited for the purpose. They may be placed in compartments forward of each other on the center line; they may be placed at any desired height above the base line; and, in fact, there is practically no limit to the variety of the arrangement.

The result of this flexibility is that a ship can be designed to give far more adequate protection to the ship and machinery against damage by torpedoes and gunfire than is the case with any other type of machinery. The main motors, which are directly connected to the shafts, are very small compared with a geared turbine, so that the compartments in which they are placed will be very small and will not menace the ship in case they are flooded. These compartments are, of necessity, vulnerable because they must be located outboard. The motors can be placed very much further aft than can steam-driven turbines, and the length of propeller shafting can be very materially reduced, with consequent reduction of liability to derangement of the shaft itself on account of injury to the ship, and also reduction of danger to the ship itself on account of the shafting not having to pierce a number of watertight bulkheads. The most important auxiliaries can be concentrated in the machinery compartments located on the centerline of the ship where they can be best protected, instead of being scattered around the ship in various vulnerable turbine rooms, as in the case of gear-driven installations.

Electric Drive Gives Ideal Arrangement

From an engineering point of view, electric drive gives an ideal arrangement, as it is possible to group the boilers around the engines in such a way as to give the minimum length of steam and other piping, as well as a reduction in the diameter of the pipes and in complication of their arrangement. This is of the greatest importance in the case of the battle cruisers where the problem of getting steam from the boilers to the engines becomes a serious matter, if it is attempted to make the orthodox arrangement of fire rooms and engine rooms with all the boilers forward of the machinery space and all of the steam pipes united before they are brought to the turbines. The maximum size of steam piping, except for a short section at each turbine, is very little greater on the battle cruiser as laid out with electric drive than it was on former battleships, and the total length of main steam piping is not much greater on the battle cruisers than it is on some of the former battleships.

Propelling Machinery of the New Mexico

The *New Mexico* is one of three sister battleships, the other two being the *Mississippi* and the *Idaho*. The first of these is equipped with direct-connected Curtis turbines and the latter with direct-connected Parsons turbines, and both ships have geared cruising turbines. The illustration, Fig. 1, gives a general idea of the size of the *New Mexico*. Her principal dimensions are as follows:

Length overall	624 feet
Length on load waterline	600 feet
Breadth, extreme	97 feet 4½ inches
Draft	30 feet
Displacement	32,000 tons
Designed speed	21 knots

The main propelling machinery of the *New Mexico* consists of two alternating current turbo-generators, four induction motors, two 300-kilowatt direct-current exciters,

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two motor generator boosters, main switchboard, exciter switchboard, ventilating blowers for the main motors, and the necessary wire and cable. The weight of the above machinery is approximately 500 tons.

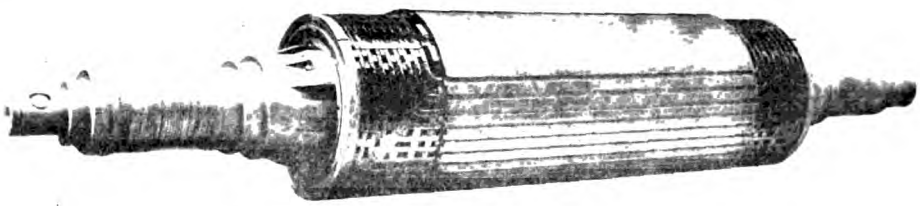
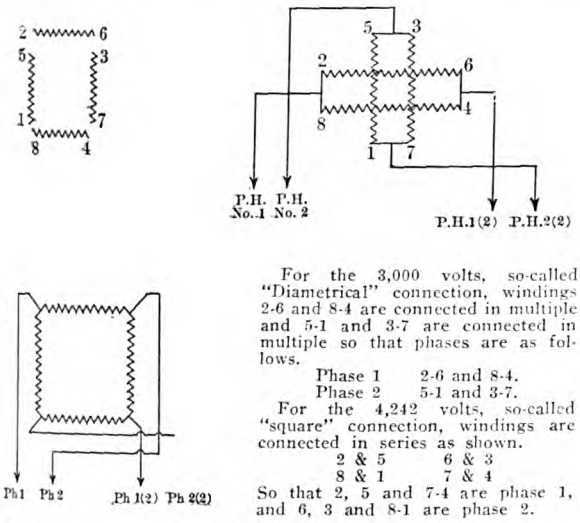


Fig. 5.—Rotor of High-Speed Turbine Generator

MAIN GENERATORS

The main generators are two-pole, quarter-phase, having a maximum capacity of about 11,500 kilowatts. Each generator is provided with a disconnecting switch which is double-throw. In one position of this switch the windings of the generator are arranged in the series or square connection, and in the other position of the switch the generator windings are arranged in parallel or diametrical connection. The first position is used when one generator is operating two motors, and under this condition the maximum voltage of the generator will be 4,242 volts. The second condition is when one generator is operating four motors, and under this condition the maximum voltage will be 3,000 volts. This arrangement enables the generator to utilize to the best advantage the doubled current capacity of the motor circuit when using four motors, and improves the overall efficiency of transmission.

The arrangement of windings is shown diagrammatically in Fig. 3. With this exception, the generators differ very little from the ordinary commercial type of alternator, except that special care was taken in the treatment of the stator coils, particularly the projecting end windings, in order to make the insulation moisture proof. The generator field was also designed with a liberal margin in regard to heating, to be able to take care of the overexcited condition that arises when maneuvering. Figs. 5 and 14 show in detail the construction of the generator.



For the 3,000 volts, so-called "Diametrical" connection, windings 2-6 and 8-4 are connected in multiple and 5-1 and 3-7 are connected in multiple so that phases are as follows.

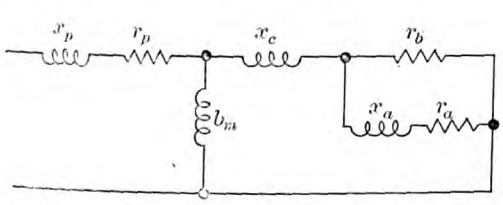
Phase 1 2-6 and 8-4.
Phase 2 5-1 and 3-7.

For the 4,242 volts, so-called "square" connection, windings are connected in series as shown.

2 & 5 6 & 3
8 & 1 7 & 4

So that 2, 5 and 7-4 are phase 1, and 6, 3 and 8-1 are phase 2.

Fig. 3.—Diagrammatic Sketch Showing Arrangement of Windings



x_p = reactance of primary winding.
r_p = resistance of primary winding.
x_c = mutual reactance of the two squirrel cages.
b_m = magnetizing susceptance.
r_b = resistance of upper squirrel cage.
r_a = resistance of lower squirrel cage.
x_a = reactance of the lower squirrel cage, which is not mutual with the upper squirrel cage.

Fig. 4

TURBINES

The turbine differs very little in its construction from the ordinary commercial turbine used for driving alternators; there are a few points of difference, however. The casing is divided at the low pressure end by a plane at right angles to the axis, so that it is possible to lift that portion of the casing which covers the blading without disturbing the exhaust connection to the condenser overhead.

The governor differs from the ordinary type of governor in that it has a movable fulcrum which makes it possible quickly to change the speed at which the governor will hold the turbine. All speed changes are accomplished by shifting this fulcrum.

The turbine has two openings in its casing for the admission of exhaust steam from the exciters or the auxiliary exhaust line, and there is an automatic valve in this exhaust line which is operated by the governor-controlling mechanism. When the governor shuts all main steam off the turbine, further movement will open this automatic valve and by-pass the auxiliary exhaust to the main condenser.

The turbine is provided with an overspeed governor which closes the main throttle and also closes automatic trip valves in the lines which supply auxiliary exhaust steam to the fifth and eighth stages of the main turbine, thus shutting off all sources of supply of steam to the main turbine. The control mechanism of the governor is extended to the center engine room by means of bell-cranks and levers. The arrangement of the governor mechanism is shown diagrammatically in Fig. 6. The details of the turbine are shown in Fig. 7.

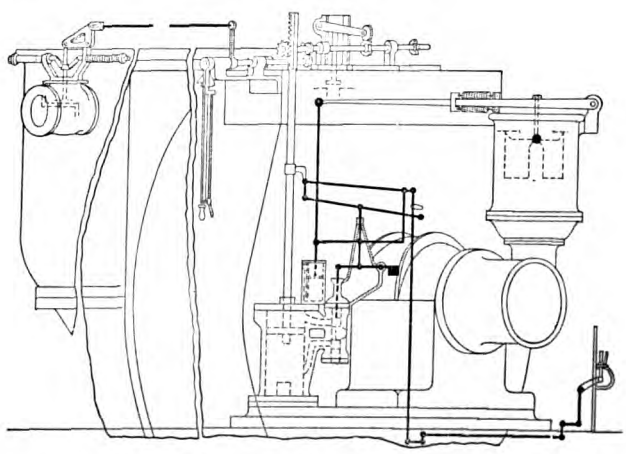


Fig. 6.—Arrangement of Connections of Operating Mechanism

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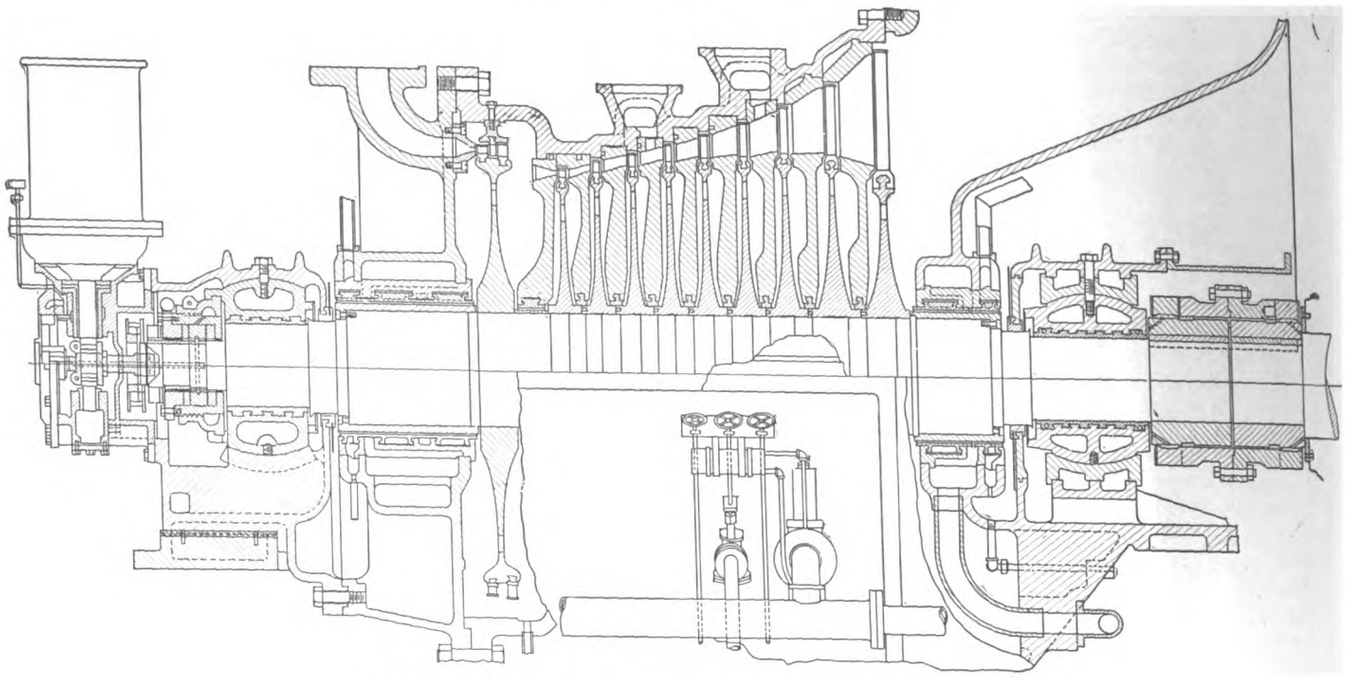

Fig. 7.—Assembly Cross Section of 10-Stage Horizontal Steam Turbine

The main motors are designed to give about 29,000 horsepower at 167 revolutions, which corresponds to a speed of 21 knots of the ship. The motor stator windings are arranged to provide for pole changing and are provided with pole-changing switches which give 24 poles on the stator when in one position and 36 poles when in the other position. The motor stator is provided with only one winding and the pole changing is accomplished by changing the arrangement of this one winding.

Motors

The motors differ more from previous designs than any other part of the machinery. It is believed that these are the first motors of this type constructed, other than experimental ones. They are of the double squirrel cage type with two independent sets of rotor windings in two slots which are separated by a deep air gap of narrow section. The construction of the slot is shown in Fig. 9. The construction of the end windings of the stator and rotor is shown in Figs. 12 and 13.

It will be noted that extreme care has been taken in arranging the short-circuiting rings to provide amply for the very great expansion which takes place in these windings when maneuvering, due to the large rushes of current. The inner squirrel cage, or lower bar in the slot, is of low resistance, while the outer squirrel cage is of high resistance. In operating under normal conditions with the motor running at practically the synchronous speed of the generator, the two squirrel cages act like parallel circuits.

Fig. 4 shows an equivalent circuit of this type of motor. From this figure it will be seen that at low frequencies of the rotor, such as obtain when the motor is running at practically the synchronous speed of the generator, the reactance of the rotor is very small, whereas with large slips, such as obtain when reversing, the reactance is very much greater. The physical explanation of what takes place is that during ordinary running the rotor flux circles both squirrel cages, but when the frequency of the rotor becomes high, the flux is forced across the narrow air gap, practically short-circuiting the inner squirrel cage and thus giving the effect of a squirrel cage of high resistance and providing the necessary torque for reversal.

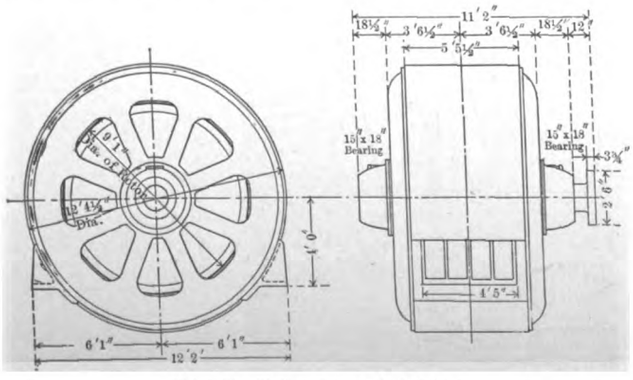

Fig. 8.—Dimensions of Motor

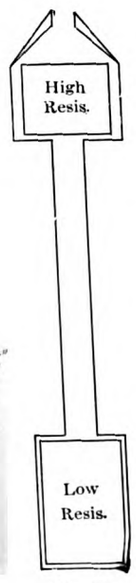

Fig. 9

The torque curve of the motor will be a resultant of the two squirrel cages and the shape of this curve is shown in Fig. 15. It will be seen that the torque required for reversal is very large owing to the peculiar shape of the torque curve of the propeller, which is shown on the same figure. In fact, the shape of the propeller torque curve during reversal is the deciding one in the design of induction motors for this work and makes the problem very much more difficult than would be the case if the torque dropped in a uniform manner all the way down. This figure also shows that it is necessary to slow the turbine down during reversal, otherwise the motor could never pull into synchronism with the generator, as the torque required to drive the motor astern at the same speed as when going ahead is several times the latter.

Control Gear and Switches

The control gear and switches for the propelling equipment are mounted on the main

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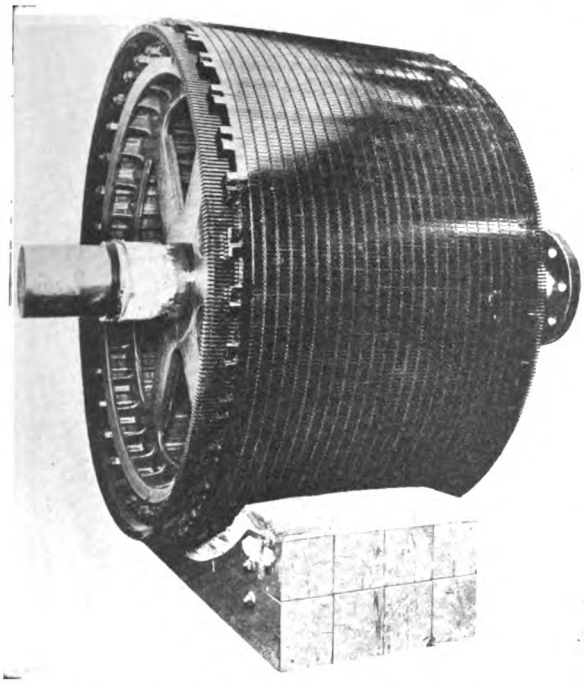

Fig. 10.—Double Squirrel Cage Induction Motor Rotor

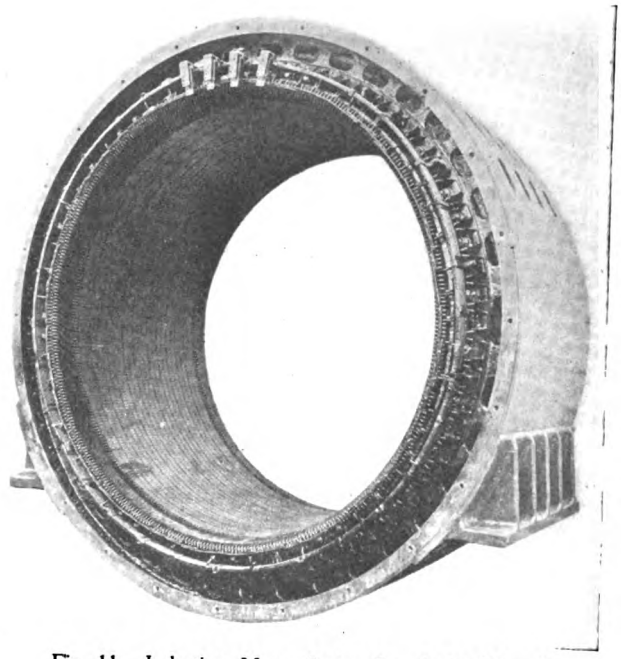

Fig. 11.—Induction Motor Stator Completely Wound
The stator windings are provided with pole-changing switches which give either 24 poles or 36 poles

and exciter switchboards, which are shown in Figs. 16-24. The exciter switchboard contains the main generator field switch and the switches necessary for the various auxiliaries that are motor driven. The rest of the equipment is contained in the main switchboard, except the generator disconnecting switches, which are mounted on the engine room bulkheads, just outboard of the main switchboard on each side of the center engine room.

On the upper part of the switching structure are mounted the motor disconnecting switches, which are of the knife blade type. On the inside of the cell structure is mounted the bus tie switch which connects the two sides of the ship, making it possible to run all four motors from either generator; this is also a knife blade switch. The pole-changing and reversing switches are of the oil type and are mounted inside the cell structure of the board.

The pole-changing switches are of the laminated brush type and the 24-pole and 36-pole switches are mounted in the same oil tank; contact is made on one side for the 24-pole connection and on the other for the 36-pole connection. The same is true of the reversing switches which make contact on one side for the "ahead" direction and on the other for the "astern" direction.

The reversing switches are three-pole, the fourth wire being carried straight through to the motors. It is necessary to open one wire of the second phase when the switch is in the off position, as otherwise the motor would continue to run as a single-phase motor after having been started. Reversal is accomplished by merely crossing the two leads of one of the phases.

These switches are clearly shown in the accompanying photographs. Only one lever is used for operating the reversing switches of one pair of motors, and the same is true of the pole-changing switches.

The speed lever is mounted on the front of the switchboard and is connected by rods and bell cranks to the governor mechanism already described and shown in Fig. 6. The steam limit lever is mounted on the switchboard directly underneath the speed lever and connects to the governor mechanism by means of rods and bell cranks.

This steam limit lever, when set at any given position, limits the amount of steam that the turbine can take, by interposing a stop in the way of the governor. This lever is necessary on account of the big change in power that takes place when the ship is turning. The turbine, being at all times under control of a governor, will attempt to run at a constant speed regardless of the power used, and in turning with full rudder at full speed of the ship the power required for this purpose is far in excess of what the generator is capable of giving, so that if a limit were not set on the amount of steam that the turbine can use at any given speed the result would be that the generator would be unable to hold up its voltage when the excess power is thrown on it and the

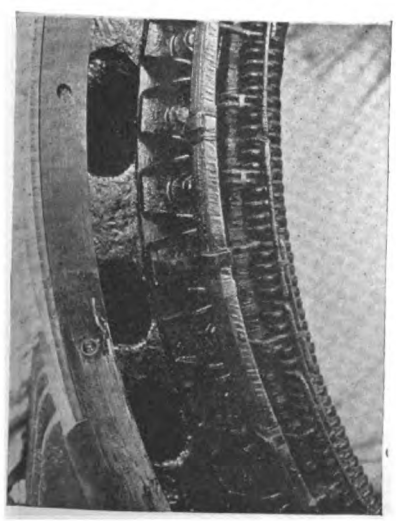

Fig. 12.—Section of Stator Winding

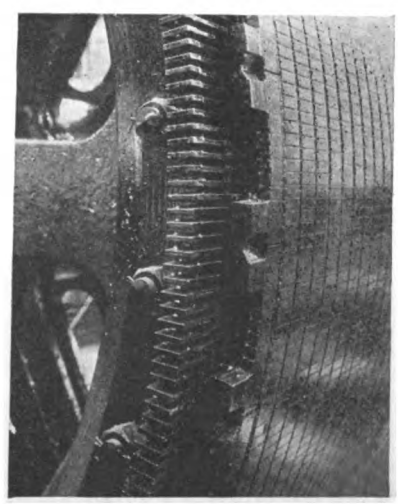

Fig. 13.—Section of Rotor Winding

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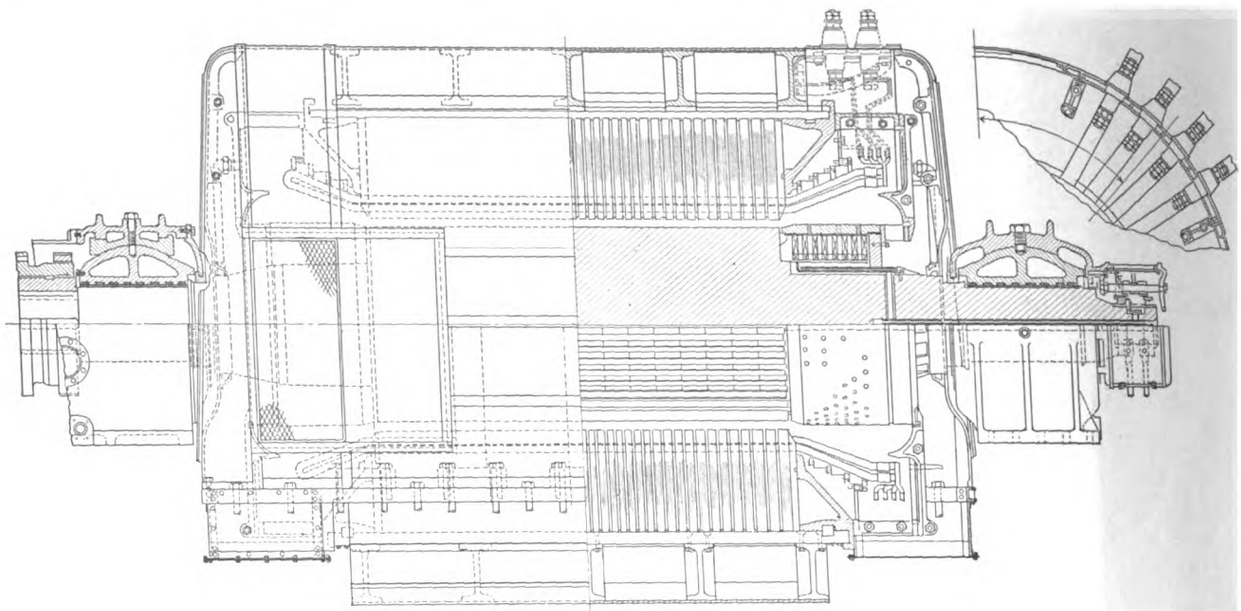

Fig. 14.—Assembly Drawing of Generator

motors would drop out of step. The field lever is mounted alongside the speed lever and operates both the solenoid for closing the main field switch and the rheostat of the booster which controls the strength of the main field. The main field switch is solenoid operated and is mounted on the exciter switchboard.

The Booster

The booster is a motor generator set, the motor end of which is a constant speed motor; the field current for the main generator passes in series through the generator end of the booster. The field lever on the switchboard varies the field of the booster generator and hence its voltage, thus regulating the voltage imposed on the slip rings of the field of the main generator. The field of the booster generator is arranged so that in the mid-position of the field lever it has no field at all; in full throw of the field lever in one direction the generator boosts the 300-kilowatt generator voltage about 60 volts, and in the other position of the field lever it bucks it about 60 volts.

The booster was used for varying the field of the main generator instead of using a generating set for this, because it was desired to have the exciting sets the same size and construction as the ship's power and lighting sets,

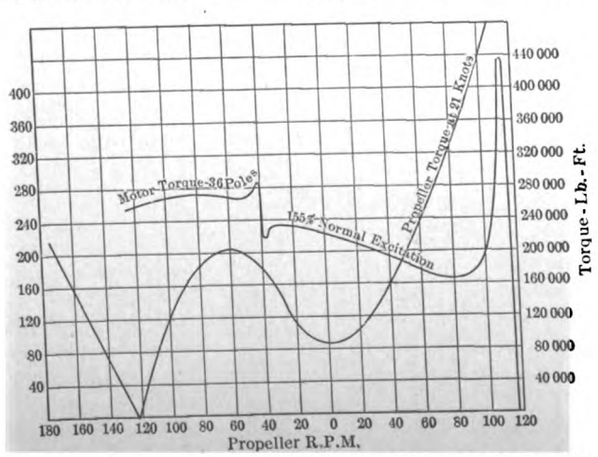

Fig. 15.—Curves Calculated from Following Data at 21 Knots. Total Shaft Horsepower 29,000

which were 300 kilowatts, but the power used for excitation was only about 55 kilowatts, so it was decided to utilize the remainder of the power of the 300-kilowatt sets for running the main engine auxiliaries, and it was, of course, necessary to keep the voltage constant on the 300-kilowatt sets when using them in this way.

General Arrangement of Propelling Machinery

The general arrangement of the propelling machinery and its auxiliaries is shown in Fig. 26. This also gives a diagrammatic arrangement of the alternating-current and direct-current wiring. The main circulating pumps, main condensate pumps, main air pumps, and forced lubrication pumps, are motor driven and are run from the 300-kilowatt exciter sets in the center engine room. The condensate pumps are of the double inlet volute type. The air pumps are of the reciprocating dry vacuum type built by Wheeler Engineering Company. The main circulating pumps are built by the Alberger Company, and the forced lubrication pumps are of the Kinney rotating plunger type. The forced lubrication pumps supply oil for the turbo-generators, motor and thrust bearings, and also for the operation of the main governor hydraulic relay. The ventilating blowers for the main motors are also supplied with power from the exciting sets. The exciter switchboard is supplied with power from the ship's after distribution room, as well as from the exciters in the center engine room, and each of the motor-driven main engine auxiliaries is supplied with power from a double-throw switch which can be thrown to either the exciter bus or the ship's circuit bus, thus giving two sources of supply for current at all times.

Interlocking Devices

The various switches and levers used in the operation of the machinery are provided with interlocks so that it is impossible to do any damage to the machinery through mistakes in operation. The motor disconnecting switches and the generator disconnecting switches are provided with electric locks so they cannot be moved unless the main generator field switch is open, assuring that all circuits are dead. The doors leading to the inside of the main switchboard are also electrically locked in the same man-

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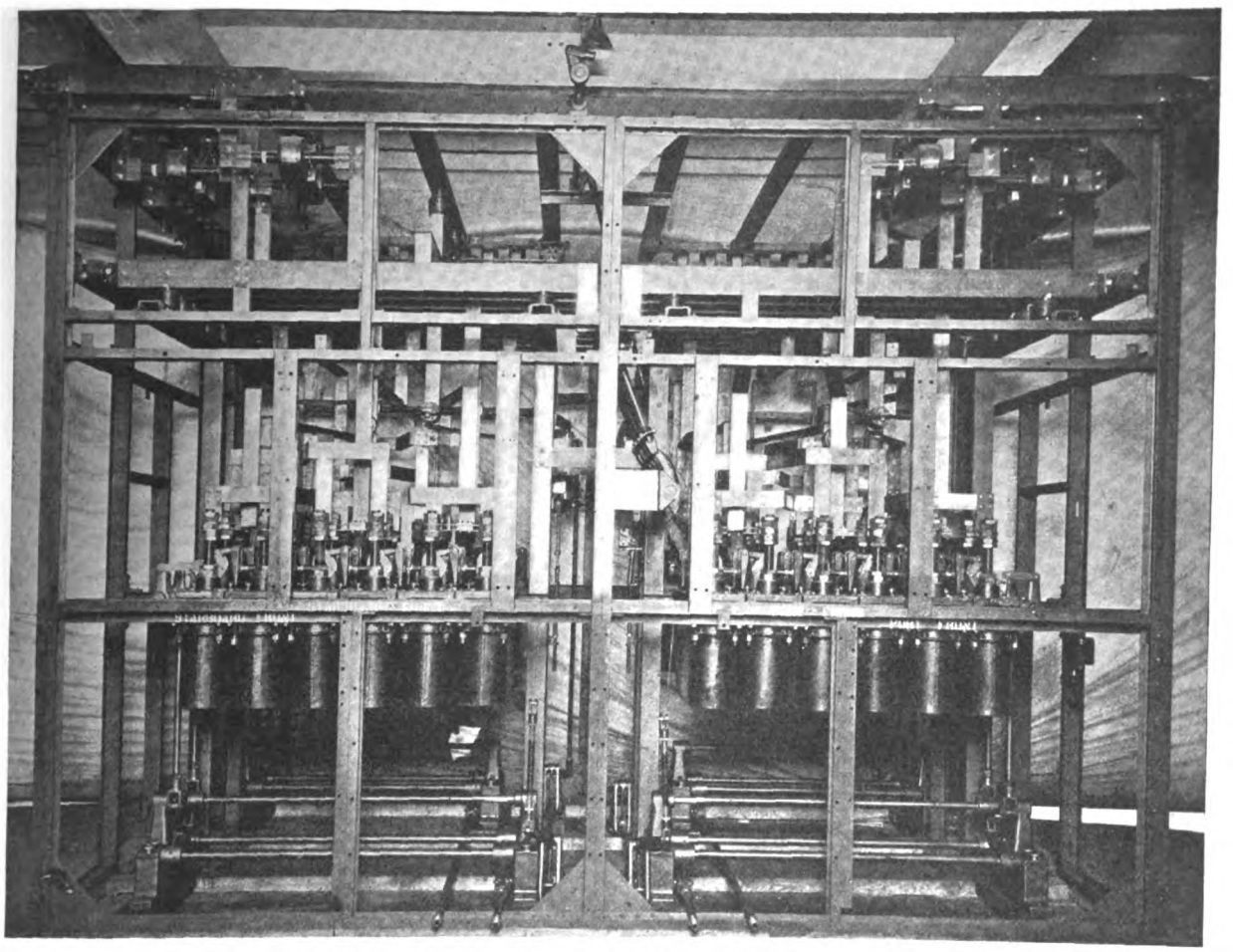

Fig. 16.—Propulsion Control Equipment, Front View, With Panels, etc., Removed

ner. This prevents anyone from getting at the bus tie switch, which is located inside the switching structure, unless all circuits are dead. The bus tie switch and the two generator disconnecting switches are mechanically interlocked so that only two of these switches can be closed at any one time, thus preventing putting the two main generators in parallel. They are also interlocked so that the generator disconnecting switches can be thrown only into the high-voltage position of the generator when the bus tie switch is open, and only into the low-voltage

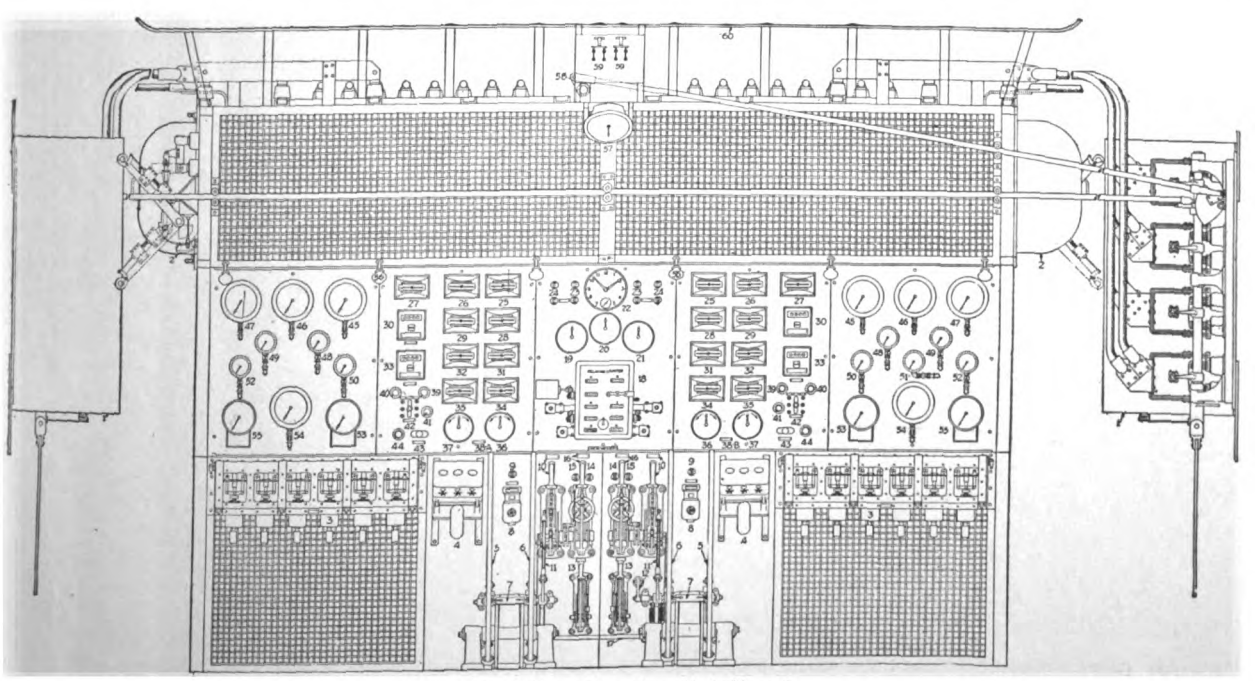

Fig. 17.—Main Operating Switchboard

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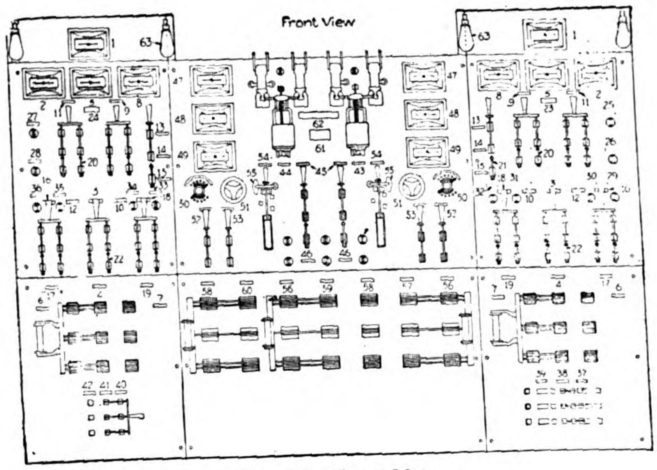

Fig. 18.—Front View

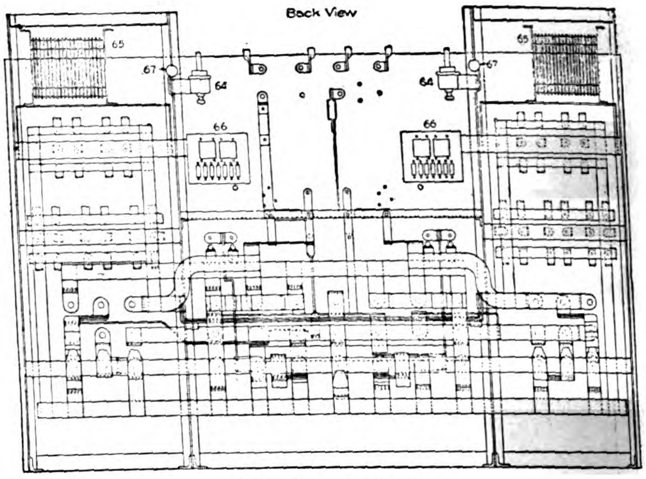

Fig. 19.—Back View

position of the generator when the bus tie switch is closed, thus insuring that the generator will always be run with low voltage when driving four motors and on high voltage when driving only two motors.

The pole-changing and reversing levers are mechanically interlocked with the field levers so that they cannot be moved unless the field lever is in the open position, thus insuring that all circuits are dead. The pole-changing and reversing levers are also electrically locked by an under current relay on the main generator circuit, which prevents these switches from being opened until the current in the main generator circuit has dropped to a predetermined value. This is an additional safeguard on the lock from the field lever, which was added because it was found that the field lever could be operated so rapidly as to make it possible to open pole-changing and reversing levers with large currents still flowing; and, while these switches are built to do this, it makes the operation very much easier on both the generators and the switches to allow a time interval of about three seconds before opening these switches.

The pole changing and reversing levers are mechanically interlocked so that the reversing levers cannot be thrown in the astern position unless the pole changer is in the 36-pole position. This insures that the maximum torque of the motor will be available for reversing, as the maximum torque is greater on the 36-pole condition than on the 24-pole condition.

The field levers and speed levers are mechanically interlocked so that the speed lever is carried to the low speed whenever field is taken off the main generator. Also, any large increase of speed will carry the field lever with it, thus increasing the strength of the main generator field. This arrangement insures that large increases of speed

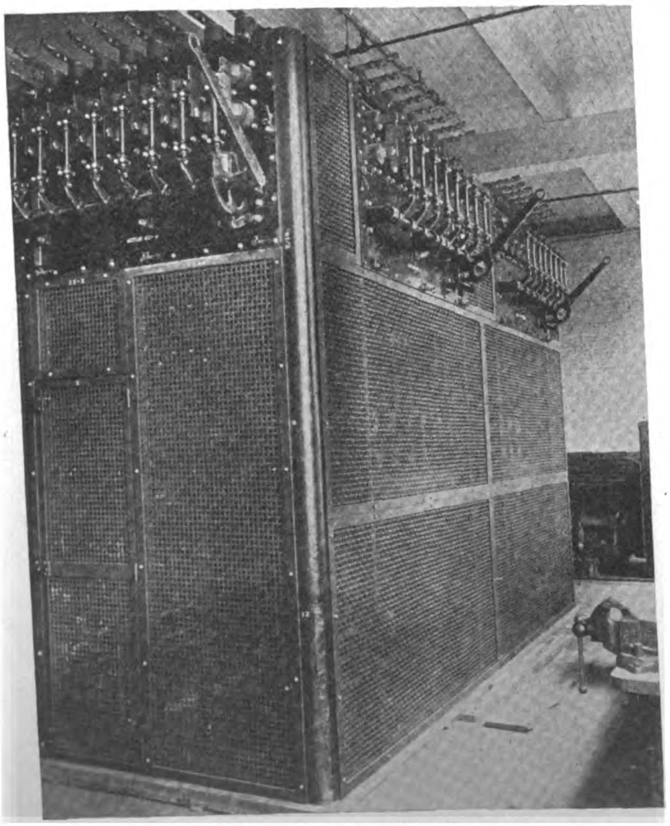
Fig. 20.—Cell for Propulsion Control Equipment; Port and Rear View

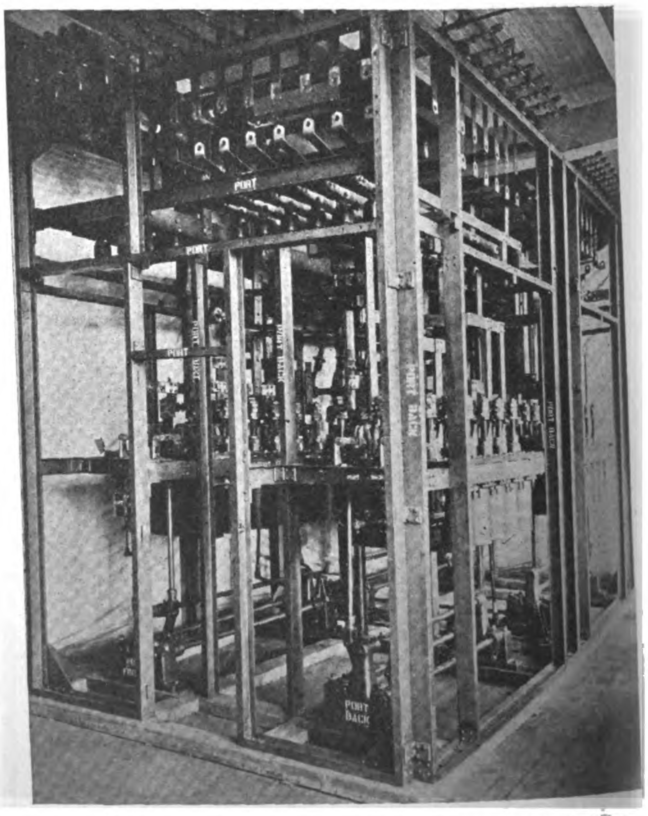
Fig. 21.—Propulsion Control Equipment; Partial Back View With Grille Work Removed

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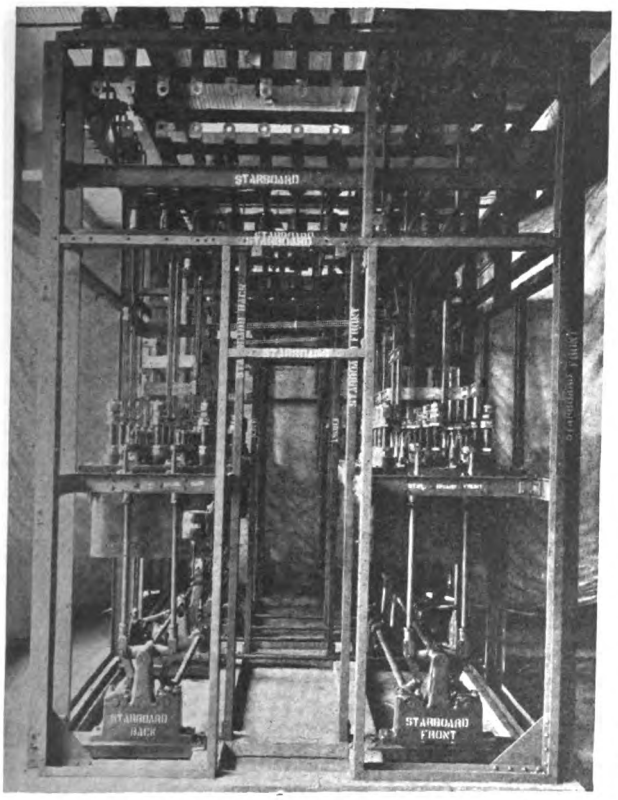

Fig. 22.—Propulsion Control Equipment; Starboard Side View, With Grille Work, etc., Removed

will not be made without corresponding increases in the field strength and it also insures that the turbine speed will be reduced before the reversal of the main motors is effected.

In addition to these interlocks, there is provided a balanced relay which is energized by the two phases of the generator and which is inoperative as long as the current strength in all four leads is the same; but if one of the phases should become short-circuited, the balance would be disturbed and this relay would trip out the main field switch.

Operation of the Machinery

The operation of the machinery is as follows:

(1) *Getting under way with one generator and motors on 36-pole connection.*—Assume that the ship is going to get under way with one generator and that the maximum speed will not be over 15 knots. This means that the

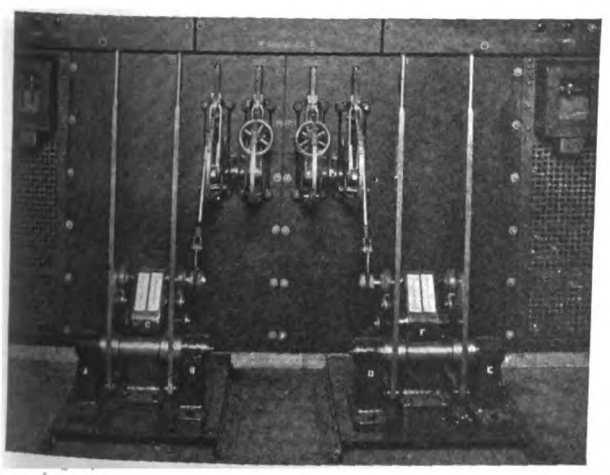

Fig. 23.—Steam Field and Motor Control Levers in Off Position

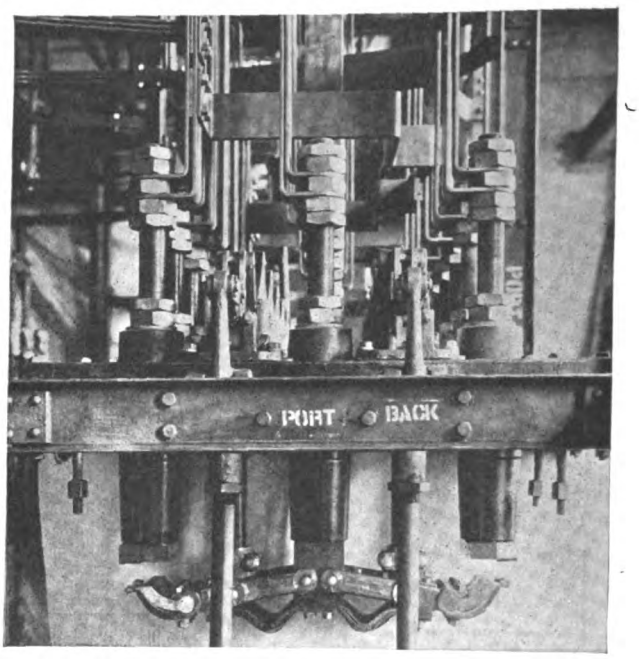

Fig. 24.—Propulsion Control Equipment; Detail View of Oil Switch

motors will be operated on the 36-pole connection. Before reporting ready to get under way, the generator that it is desired to use would be tested out and then set to run at low speed; the bus tie switch would be closed, and the generator disconnecting switch would be closed in the low-voltage position. The field switch of the generator and the pole-changing and reversing levers would be open. On receiving a bell "Ahead"—

(a) The pole-changing switch would be thrown in the "36-pole" condition.

(b) The reversing lever would be thrown in the "Ahead" position.

(c) The field switch would be closed and brought up to the desired field strength.

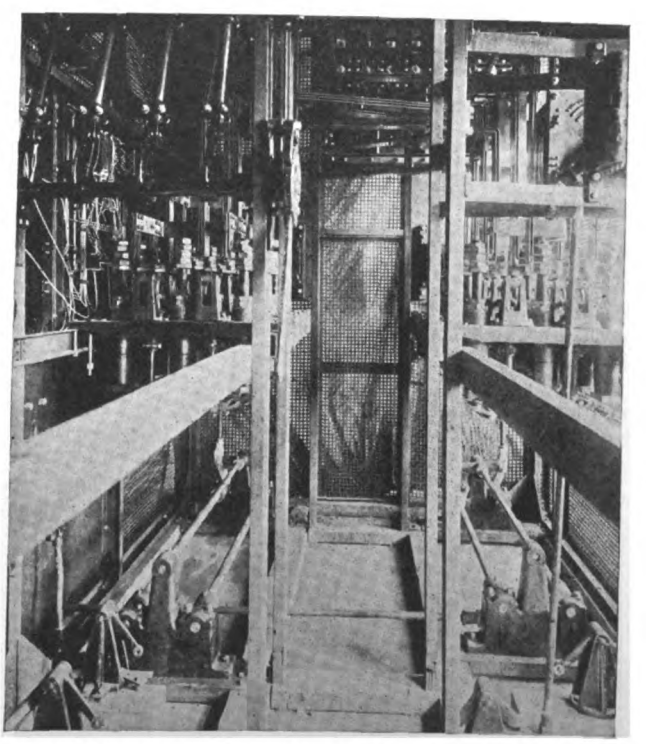

Fig. 25.—Interlocks Between Field Switch and All Other Switches

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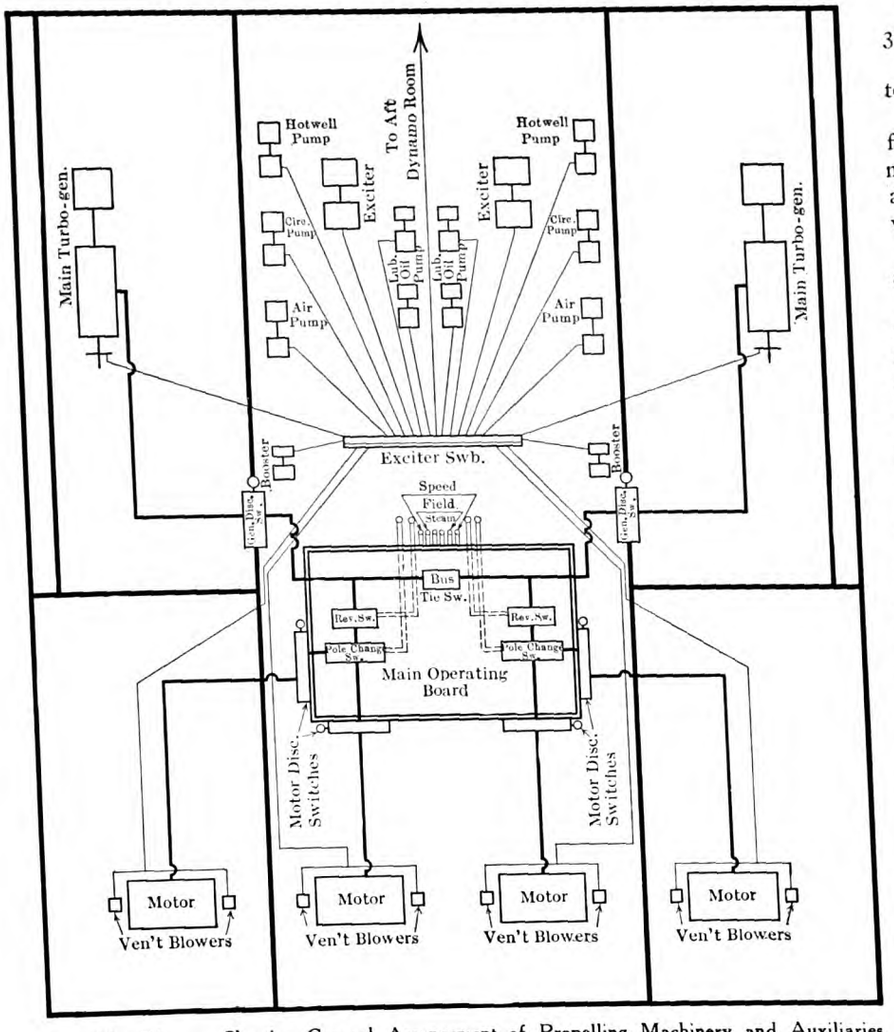

Fig. 26.—Diagram Showing General Arrangement of Propelling Machinery and Auxiliaries

(d) The turbine would then be brought up to the desired speed.

(2) *Reversing.*—With the ship going ahead under conditions described above, under (1), on receiving a bell "Astern"—

(a) The field switch would be opened and the speed lever brought to low speed at the same time.

(b) As soon as the under current relay operates, the reversing levers would be thrown to the "Astern" position.

(c) The field switch would then be closed and over-excitation applied to the generator until the motors have been reversed and come up to synchronous speed when the field would be reduced to its normal value.

(d) The speed of the turbine would then be brought up to whatever is desired.

(3) *Getting under way with one generator and motors on 24-pole connection.*—In case it is desired to make the maximum speed greater than 15 knots, but less than 17½ knots, one generator will be used and the motors will be connected on the 24-pole condition. In this case, getting under way is exactly as described under (1), except that the pole-changing switches would be thrown into the 24-pole position.

(4) *Reversing.*—Assuming the ship to have got under way with conditions as described above, under (3), on receiving a bell "Astern," reversal would be accomplished in the following manner:

(a) Open the field switch and throw the speed lever to low speed at the same time.

(b) Throw pole changers to 36-pole position.

(c) Throw reversing switches to "Astern" position.

(d) Apply over-excitation to the field of the main generator until motors have come into synchronism and then reduce field to normal value.

(e) Bring turbine up to desired speed.

(5) *Getting under way with two generators.*—In this case the bus tie switch would be open and the two generator disconnecting switches would be closed in the high-voltage position. Field switches would be open, generators would be running at slow speed, and pole-changing and reversing switches would be open. If bell "Ahead" is received, the operations carried out would be exactly as described under (3), except that it would be performed on two generators instead of one.

(6) *Reversing.*—After having got under way with conditions as above described, if a bell "Astern" were received the operations would be exactly as described under (4), except that they would be carried out for two generators instead of one.

Official Trials

The *New Mexico* has had two sets of official trials. The first trials were conducted after the ship had been out of dry dock about seven weeks, and this increased the shaft horsepower necessary to make the guaranteed speed of 21 knots by over 4,000 horsepower, so a second set of trials were run when the horsepower came down to 29,100 for 21 knots.

The ship averaged 21.08 knots for her four-hour full power run, and 21.31 knots was the average of the five high points on standardization. The turbine water rates were considerably better on the first trials than on the second, owing to the fact that the first trials were run in smooth water, while the second trials were run in rough weather, which increased the horsepower for the speed, and for which no allowance was made, as the standardization horsepower was used.

The water rates obtained in the trials were as follows:

Speed	Water Rate	
	First Trial	Second Trial
Full speed	12.29	12.01
19 knots	11.926	12.33
15 knots	11.667	12.475
10 knots	14.223	13.96

These water rates include the steam from the 300-kilowatt exciters, which furnished power for excitation and also for driving the main air pumps, main circulating pumps, main condensate pumps, forced lubrication pumps, and ventilating blowers for the main motors.

In addition to the trials for steam and fuel consumption, trials were made to demonstrate satisfactory backing qualities when steaming at full power; also to deter-

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mine satisfactory performance when turning with full rudder and at full speed, both in the case of propulsion by one generator and also by two generators.

Numerous other trials were conducted, such as standardizing with two screws driving and two running idle, and considerable new data was obtained in regard to the action of screw propellers. In all the tests carried out the machinery gave very satisfactory performance.

TURBINE EQUIPMENT (see Fig. 7)

Part No.	Description of Apparatus	Name Plate Inscription
13	Steam limit control lever	Steam Limit Control Lever
14	Red bull's eye lamp for steam limit indicating switch	
15	Clear bull's eye lamp for steam limit indicating switch	
16	Speed control mechanism	Speed Control Mechanism
45	Steam gage	Main Steam
46	Steam gage	Main Turbine, Steam Chest
47	Steam gage	Main Turbine, First Stage
48	Steam gage	Exciter Exhaust
49	Steam gage	Auxiliary Exhaust
50	Pressure gage	Oil to Turbines
51	Pressure gage	Feed Water
52	Pressure gage	Oil to Governor
54	Vacuum gage	Main Condenser

GENERATOR EQUIPMENT (see Fig. 14)

1	Generator disconnecting switch, 8-p., d-t	Generator Disconnecting Switch
	*(A) Auxiliary switch, d-p., c. o.	
	*(B) Magnetic locking device	
3	Balance relay	Balance Relay
6	Reversing lever mechanism	Ahead—Astern
	*(A) K-31 oil circuit breaker, 3-p., d-t., 5,000 volt, 3,000 amp.	
	*(B) Magnetic locking device	
7	Interlock between reversing and pole-changing levers	
10	Field control mechanism	Field Control Mechanism
	*(A) Booster rheostat	
	*(B) Pipe mechanism for (A)	
11	Interlock between field control lever and reversing and pole-changing levers	
12	Interlock between bus section and field switches	
	*(A) Bus section switch, 4-p., s-t., 2,400 amp., 5,000 volt, operating mechanism and auxiliary switch	
17	Across-ship interlocking shaft for 12	
23	Red bull's eye lamp for field switch	Generator Field
24	Green bull's eye lamp for field switch	Generator Field
25	H-2 ammeter, 15 amp. with 10,000 amp. scale	Generator Ammeter
26	H-2 voltmeter, 150 volt with 6,000 volt scale	Generator Voltmeter
27	DH-3 temperature indicator { 70-250 deg. F. / 20-120 deg. C. } scale	Generator Temperature Indicator
28	DH-3 field ammeter, 600 amp. with shunt	Generator Field Ammeter
29	DH-3 field voltmeter, 300 volt	Generator Field Voltmeter
31	H-2 indicating wattmeter, 110 volt, 4 amp., 20,000 kw. scale	Generator Wattmeter
	*(A) E-18 current transformer, 3,000/5 amp	
	*(B) AQ-1 potential transformer, 4,400/110 volt, 200 w	
	*(C) Fuse support with fuse holder and fuse, 4,400 volt	
32	H-4 speed indicator, 110 volt, 1,000-2,600 r. p. m. scale	Generator Speed Indicator
39	Ammeter transfer switch	Generator Ammeter Transfer Switch
40	Voltmeter transfer switch	Generator Voltmeter Transfer Switch
41	Balance relay cut-out switch	Balance Relay Cut-Out Switch
42	Temperature indicator transfer switch	Temperature Coils
43	Temperature indicator test switch	Test
44	Temperature indicator supply switch	Indicator Supply
58	Interlock between generator disconnecting switches and bus section switch	
59	Booster generator field switch	Booster Generator Field

MOTOR EQUIPMENT (see Figs. 8-13)

2	Motor disconnecting switch, 8-p., s-t., 600 amp., 5,000 volt	
	*(A) Magnetic locking device	
5	Pole-changing lever mechanism	24 Poles—36 Poles
	*(A) K-31 oil circuit breakers, 6-p., d-t., 5,000 volt, 1,500 amp.	
	*(B) Magnetic locking device	
8	Under current relay	Under Current Relay
9	Blue bull's eye indicating lamp for 8	
18	Revolution counter	
19	Stop clock—average starboard shafts	
20	Stop clock—average all shafts	
21	Stop clock—average port shafts	
30	IS-4 watthour meter, 110 volt, 5 amp.	Motor No. 1 (or 3)
33	IS-4 watthour meter, 110 volt, 5 amp.	Motor No. 2 (or 4)
	*(A) W-2 current transformer, 800/5 amp	
	*(B) AQ-1 potential transformer, 4,400/110 volt, 200 w	
	*(C) Fuse support with fuse holder and fuse, 4,400 volt	
34	H-2 ammeter, 5 amp. with 1,600 amp. scale	Motor No. 2 (or 3) A. C. Ammeter
35	H-2 ammeter, 5 amp. with 1,600 amp. scale	Motor No. 1 (or 4) A. C. Ammeter
36	Direction indicator motor No. 2 (or 3)	
37	Direction indicator motor No. 1 (or 4)	
53	Electrical speed indicator motor No. 2 (or 3)	
55	Electrical speed indicator motor No. 1 (or 4)	

* Located inside cell.

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MISCELLANEOUS EQUIPMENT

Part No.	Description of Apparatus	Name Plate Inscription
4	Speed indicator for engine room telegraph	Starboard
22	Clock	Port
38A	Name plate	
38B	Name plate	
56	Lamp bracket	
57	Rudder position indicator	
60	Sheet iron protecting shield	

EXCITER SWITCHBOARD EQUIPMENT (see Figs. 17-19)

1	DH-3 ammeter, 150-0-150 amp. scale with shunt	Booster Motor
2	DH-3 ammeter, 200 amp. scale with shunt	Air Pump
3	D-27 lever switch, d-p., d-t., 250 volt, 135 amp.	Air Pump Bus No. 1
4	D-27 lever switch, d-p., d-t., 250 volt, 135 amp.	Air Pump Bus No. 2
5	DH-3 ammeter, 1,500 amp. scale with shunt	Main Circulating Pump
6	D-27 lever switch, t-p., d-t., 250 volt, 1,200 amp.	Main Circulating Pump—Bus No. 2
7	D-27 lever switch, t-p., d-t., 250 volt, 1,200 amp.	Main Circulating Pump—Bus No. 1
8	DH-3 ammeter, 100 amp. scale with shunt	Hotwell Pump
9	D-27 lever switch, d-p., d-t., 250 volt, 65 amp.	Hotwell Pump—Bus No. 1
10	D-27 lever switch, d-p., d-t., 250 volt, 65 amp.	Hotwell Pump—Bus No. 2
11	D-27 lever switch, d-p., d-t., 250 volt, 65 amp.	Lubricating Oil Pumps—Bus No. 1
12	D-27 lever switch, d-p., d-t., 250 volt, 65 amp.	Lubricating Oil Pumps—Bus No. 2
13	D-27 lever switch, s-p., d-t., 250 volt, 350 amp.	Booster
14	D-27 lever switch, s-p., d-t., 250 volt, 350 amp.	Generator Field
15	D-27 lever switch, s-p., d-t., 250 volt, 350 amp.	Bus
16	D-27 lever switch, d-p., d-t., 250 volt, 135 amp.	Ventilating Blower No. 1 (or 4) Bus No. 1
17	D-27 lever switch, d-p., d-t., 250 volt, 135 amp.	Ventilating Blower No. 1 (or 4) Bus No. 2
18	D-27 lever switch, d-p., d-t., 250 volt, 135 amp.	Ventilating Blower No. 2 (or 3) Bus No. 1
19	D-27 lever switch, d-p., d-t., 250 volt, 135 amp.	Ventilating Blower No. 2 (or 3) Bus No. 2
20	Switch stop for 65 amp., d-t. lever switch	
21	Switch stop for 350 amp., d-t. lever switch	
22	Switch stop for 135 amp., d-t. lever switch	
23	Name plate	Starboard
24	Name plate	Port
25	Clear bull's eye indicating lamp	Blower No. 41
26	Clear bull's eye indicating lamp	Blower No. 43
27	Clear bull's eye indicating lamp	Blower No. 42
28	Clear bull's eye indicating lamp	Blower No. 44
29	Clear bull's eye indicating lamp	Blower No. 47
30	Clear bull's eye indicating lamp	Blower No. 51
31	Clear bull's eye indicating lamp	Blower No. 49
32	Clear bull's eye indicating lamp	Blower No. 53
33	Clear bull's eye indicating lamp	Blower No. 54
34	Clear bull's eye indicating lamp	Blower No. 50
35	Clear bull's eye indicating lamp	Blower No. 52
36	Clear bull's eye indicating lamp	Blower No. 48
37	D-27 control bus transfer switch, t-p., d-t., 250 volt, 65 amp., with resistance	After Distribution Board
38	D-27 control bus transfer switch, t-p., d-t., 250 volt, 65 amp., with resistance	Three-Wire, D. C. Control Buses
39	D-27 control bus transfer switch, t-p., d-t., 250 volt, 65 amp., with resistance	To Control Bus Selector Switch
40	D-27 lever switch, t-p., d-t., 250 volt, 65 amp.	Exciter No. 2
41	D-27 lever switch, t-p., d-t., 250 volt, 65 amp.	Exciters
42	D-27 lever switch, t-p., d-t., 250 volt, 65 amp.	Exciter No. 1
43	Solenoid operated field switch, d-p., s-t., 250 volt, 350 amp.	Generator Field—Starboard
44	Solenoid operated field switch, d-p., s-t., 250 volt, 350 amp.	Generator Field—Port
45	D-27 lever switch, s-p., d-t., 250 volt, 350 amp.	Generator Field, 240 Volt
46	D-27 lever switch, s-p., d-t., 250 volt, 350 amp.	Generator Field, 120 Volt
47	DH-3 ammeter, 2,000 amp. scale with shunt	Positive Ammeter
48	DH-3 ammeter, 2,000 amp. scale with shunt	Negative Ammeter
49	DH-3 voltmeter, 300 volt scale	Starboard (or Port) Voltmeter
50	Voltmeter transfer switch, d-p., 6-t.	Bus, Voltage, Grounds Pos. Neg.—Pos. Neu.—Neu. Neg.—Pos. Grd.—Neu. Grd.—Grd. Neg.
51	Field rheostat mechanism	
52	D-27 lever switch, s-p., s-t., 250 volt, 350 amp.	Booster Generator, Neg.
53	D-27 lever switch, s-p., s-t., 250 volt, 350 amp.	Booster Motor, Neg.
54	H-16 starting switch, s-p., 4-t., 250 volt, 150 amp.	Booster Motor Starter
55	Mechanical interlock between booster motor starting switch and generator field switch	
56	D-27 lever switch, t-p., 6-t., 250 volt, 1,800 amp.	Bus No. 1
57	D-27 lever switch, t-p., 6-t., 250 volt, 1,800 amp.	Starboard Exciter
58	D-27 lever switch, t-p., 6-t., 250 volt, 1,800 amp.	Bus No. 2
59	D-27 lever switch, t-p., 6-t., 250 volt, 1,800 amp.	After Distribution Board
60	D-27 lever switch, t-p., 6-t., 250 volt, 1,800 amp.	Port Exciter
61	Bureau name plate	
62	Name plate	New Mexico
63	Lamp bracket	
64	Solenoid control relay, s-p., 125 volt	
65	Generator field discharge resistance	
66	Fuse base	
67	Lamp bracket	

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Electric Drive on Merchant Ships

Comparison of Electric Drive With Reduction Gearing—Electric Propulsion of Single-Screw Cargo Vessel Proposed

BY W. L. R. EMMET*

JUSTIFICATION for electric drive on merchant ships is that it affords a transmission efficiency practically equal to that obtainable with gears of suitable speed reduction, and that it accomplishes this result by a simpler and more reliable means. The writer has given much thought to this problem, both with respect to geared equipments and to electric drive, has conducted many experiments, and obtained much practical experience. A year or two ago he was of the opinion that electric drive would not be commercially justified on low-speed merchant vessels on account of higher cost and a somewhat less transmission efficiency. More correct studies of this subject and the development of improved electrical methods have shown that the difference of transmission efficiency is very slight and that the small difference of cost which will apply to a just comparison is much more than justified by many practical advantages accomplished.

Geared turbine applications to merchant ships have been of two kinds: first, single-reduction equipments with relatively low-speed turbines, and, second, double-reduction equipments with high-speed turbines. The General Electric Company was the first to produce equipments of the latter type, which afford a less efficient transmission but admit the use of a very much better and simpler turbine. By the introduction of single-reduction turbine equipments, Parsons showed by comparative tests a reduction in steam consumption of about 19 percent as compared with the reciprocating engine. Four years ago I predicted a further reduction of 14 percent by the use of high-speed turbines with double-reduction gearing, and very complete data and tests have proved the correctness of this prediction.

Single-Reduction Gears Abandoned in British Ships

An interesting fact in this connection is that in recent designs Parsons has abandoned the single-reduction method, and the new standard English ships are being built with double-reduction gearing and high-speed turbines. At the same time that this change is being carried on on a large scale in England, the DeLaval Company and others in this country, with the approval of the Emergency Fleet Corporation, have made the opposite change and have abandoned double reduction in favor of single reduction, on the ground that the gearing could be made more reliable. An interesting fact in this connection is that the principal troubles with marine gears have developed in the low-speed element.

These facts illustrate the uncertainties of the gear situation and the unformed state of opinion relating to it.

Machinery which drives a propeller may be subject to very severe shocks and periodic vibrations, and gear troubles have developed on ships in a manner which seems erratic and very difficult of classification.

The efficiency of ship gears has also been overestimated. Careful tests have indicated that the efficiency of transmission in a 2,500-horsepower double-reduction equipment, running smoothly and in good condition, does not exceed 94.5 percent, and it must be remembered that the equipment is further handicapped by the presence of a reversing turbine which occasions about eight times as much friction resistance as a similar turbine moving in the ahead direction. With high-speed turbines and the most improved electrical apparatus, we can get a transmission efficiency of 93.5 percent on such a ship, so that it can be safely predicted that in any vessel in which high-speed turbines are used, the difference of transmission efficiency will not exceed one percent. If, on account of gearing conditions, the turbine has to be divided into two or more parts, there is a further disadvantage through increased packing losses and other complications.

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Effects of Temperature With Use of Reversing Turbines

Another matter which is important in the comparison of geared and electric ship equipments is the effects of temperature which may arise in connection with the use of reversing turbines, particularly where high degrees of superheat are applied. In an electrically driven ship the turbine always moves in the same direction and never requires to be stopped except when operation is entirely discontinued. Thus its service is equivalent to that of a turbine on shore. When a turbine is operated in the reverse direction the friction is at least eight times as great as in the normal direction. The reversing elements of our 2,500-horsepower ship turbines, although very small in diameter and of a minimum rotation loss, will, when operated in a 10-inch vacuum at full speed, heat up enough to turn blue. In our tests we regularly avoid this by introducing water. The introduction of water or any fluid which may limit this heat will naturally cause a large increase of loss.

An experiment which suggests the possibilities of such heat troubles as have been mentioned was recently made in Schenectady. A turbine designed to operate at 3,600 revolutions per minute was forced to revolve in the reverse direction at 2,000 revolutions per minute. A small amount of steam, passed through the buckets in the normal direction while it was being reversed, produced in a short time a temperature of 940 degrees F. in the nozzles of the last stage.

Temperature variations in actual practice in ship turbines are, to a great extent, limited by the heat storage capacity of the turbine parts themselves, but there are bound to be local heatings and irregular distributions of heat, which, with high superheat, cannot fail to be a source of increased danger. Superheat affords means of greatly increased economy wherever turbines are used, and this advantage should not be sacrificed in ships where fuel economy is of such great importance. In an electrically driven ship superheat can be a source of no disadvantage to a turbine—in fact, it is likely to increase the life of the blading.

Electrical Propulsion Limited by Propeller Speed

The electrical propulsion of ships may be limited under some conditions by the matter of propeller speed, since we cannot have less than two poles in the generator, and since it is undesirable to have to provide more than 60 or 70

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poles in a motor. For ships requiring 3,000 horsepower or over and a speed of about 11 knots, a turbine operating at 3,000 revolutions per minute can be advantageously used, which, with a 60-pole motor, will give 100 revolutions per minute to the propeller and a high propeller efficiency. In higher speed vessels the conditions are generally easier. With smaller powers and propellers operating under 100 revolutions per minute it will generally be desirable to use gears, even if electrical transmission is adopted. In that case it is desirable to place the gears between the turbine and the generator instead of between the motors and propellers, as has been done.

Difficulties in Low-Speed Elements of Gearing

Experience with ship gearing indicates that the greatest difficulties arise in the low-speed elements. This is probably due to the fact that these elements receive more direct shocks from the propeller, and also that they give a much less perfect lubrication effect. There is presumably an effective oil cushioning in high-speed gears which is absent in low-speed gears.

In electric drive equipments it would generally be desirable to furnish direct current exciting current from a separate source, and it has been thought desirable to combine excitation, lighting and the driving of auxiliaries. The auxiliaries on most existing ships involve a considerable unnecessary loss of power, and by driving them electrically and exhausting a well-designed auxiliary generating unit into the feed heater and into an intermediate stage of the turbine, a very good efficiency and simple operating condition can be afforded.

The following copy of a proposal recently made illustrates the possibilities of an application to a 4,000-horsepower vessel with a single screw operating at 110 revolutions per minute:

Proposal for Electric Drive on 4,000-Horsepower Merchant Vessel

"The auxiliary generating units are of such a size that one of them will be capable of affording lighting and excitation and all the auxiliary power which has been contemplated while the ship is at sea. These units are designed to run condensing or non-condensing with a good water rate. By carrying as a spare part a suitable direct-current motor and gear which could be connected to the end of the main shaft, these auxiliary units are used to propel the ship at nearly half speed in case the main unit or main motor were unfit for service. It would in any case be desirable to have auxiliary condensing facilities for use in port, and these could be used in such an emergency.

"The main propulsion equipment consists of:

	Approximate Net Weight, Pounds
One 3,200-k. v. a., 3,500 revolutions per minute, 2,500-volt turbine generating unit	82,000
One 4,000-horsepower, 110 revolutions per minute, alternating-current motor	80,000
Instruments and controlling mechanism for the above	9,000

"Our calculations concerning the performance of this equipment show the following results, and, since the efficiency of every part is thoroughly understood, it is certain that these results can be actually obtained in practice. When the turbine is operating with a steam pressure of 265 pounds gage at the throttle, 150 degrees F. superheat, and 28.5 inches vacuum, we should obtain a brake horsepower delivered to the propeller shaft with 9.4 pounds of steam, not including auxiliary steam.

"In giving guarantees, we must make an allowance for possible errors in testing and will guarantee that this water rate, under these conditions, will not exceed 10 pounds per shaft horsepower hour.

"*Auxiliaries.*—We have assumed that the boiler feed pump is steam-driven and requires 2,500 pounds of steam per hour, also that a Blake twin-beam wet and dry air pump is used which consumes 600 pounds of steam, making a total of 3,100 pounds of steam from these pumps for feed water heating. The following electrically driven auxiliaries have been assumed:

	Motor Speed	Horsepower	Electrical Input, Horsepower
Circulating pump	1,700/1,000	75.00	82.5
Excitation		80.00	80.0
Lighting		20.00	20.0
Oil cooler	1,700	1.25	1 5
Fire room blowers	850	20.00	22.5
Steering	800	5.35	6.0
Continuous load			212.5 = 157.0 kilowatts

	Motor Speed	Maximum Horsepower	Average Continuous Horsepower
Sanitary pump	1,700	5.0	2.5
Fresh water pump	1,700	5.0	2.5
Refrigerating pump	1,700	5.0	2.5
Evaporator pump	1,700	1.0	1.0
Workshop	1,700	5.0	2.5
Bilge pump	850	5.0	5.0
			16.0
Total input			18.0 = 13.5 kilowatts
Total maximum load			170.5 kilowatts

"In addition to the above motors there is included one 20-horsepower, 900 revolutions per minute induction motor for operating the blower for main motor ventilation. In connection with the above motors, while we are including hand-operated starting devices, no mechanical parts such as pumps, blowers, etc., are included. In other words, only motors and starters are included.

"We propose to drive these auxiliaries from two 150-kilowatt, direct-current sets, operating non-condensing against a back pressure of 5 pounds gage, with part of this exhaust used to bring up the fed water temperature to 212 degrees F. and the remainder going into a suitable stage in our turbine for additional work.

"The total flow of steam from the boiler at maximum speed will be 43,000 pounds per hour. Assuming 14 pounds of steam evaporated per pound of oil (same efficiency as Babcock & Wilcox boilers on battleship *Wyoming*), this would require 3,100 pounds of fuel oil per hour, or 33.25 tons (2,240 pounds) for 24 hours. Thus the water rate, including all auxiliaries, lighting, and steam required for heating feed water, should be 11.1 pounds per shaft horsepower hour.

"The electrical apparatus proposed for this purpose is of an extremely simple and reliable type. Our records over long periods of years covering such apparatus show that only about one-tenth of one percent of the motors and generators of such voltage, which are installed in all kinds of service, show any electrical trouble in a period of ten years.

"The turbine is of the most efficient type manufactured for such a capacity and is designed with very liberal factors of safety with all the most recent features of construction. Such a turbine is capable of running at a considerable proportion of its capacity if one of its many wheels is in operating condition. Packings, bearing sleeves and other perishable parts are easily replaceable, so that under almost any combination of circumstances such a turbine can be quickly got into operative condition after it has been accidentally damaged.

"The standards of reliability are so high with such apparatus that it is believed that they occasion less risk of stoppage than is incurred in single-screw ships propelled

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in any other manner. In case, however, the novelty of such an equipment raises doubts which may increase insurance rates, a motor can be provided as stated above which will propel the ship at reduced speeds from power delivered by the auxiliary generating units.

"It is believed that the operation of these relatively large auxiliary generating units and the use of motors for driving the auxiliaries mentioned are justified from the standpoint of economy. Generating units of such a capacity will give a very good efficiency, and their operation involves no more complication of detail than is occasioned by the use of the smallest steam turbine—in fact, the details of the larger turbine are simpler and better than those of the smaller one."

The proposal quoted above describes an equipment which is in itself much less liable to trouble or interruption than any type of existing equipment used on a single-screw ship, and at the same time affords, at very small cost for spares, means by which the ship can be run if the main machinery is inoperative. The figures given as to results are correct and dependable, and are so good that their accomplishment in many classes of service would pay for the change in three years. With very few exceptions, the prevailing opinion of the most experienced marine engineers is that the reciprocating engine for ship propulsion is obsolete. Its replacement is inevitable, and the General Electric Company, with its experience and facilities for development, is ready to do the work.

United States 110-Foot Submarine Chasers

Description of Special Type of Naval Vessel Which Played an Important Part in the War—Construction, Equipment and Engineering Data

BY R. P. SANBORN

SINCE the signing of the armistice and the subsequent modification of the censorship, a great deal of information has been published regarding the exploits of the American 110-foot submarine chasers, or the "110-footers," as they are popularly known. For that reason a short description of these vessels, their constructive features, arrangement and equipment may be of interest at this time.

When, early in 1917, it appeared certain that the United States would enter the war, the Navy authorities in making their preparations took account of the valuable services rendered England by her fleet of motorboats, fishing boats and other small craft, including the now famous 80-foot "M. L.'s," and took steps to provide a similar fleet for the protection of our own coast and harbors and to give our share of assistance in the offensive warfare against the submarine overseas.

The subject of patrol boats had received the attention of motorboat enthusiasts, yacht builders and designers throughout the country, and these men were called upon to give of their experience. Taking advantage of the experience of the Russians with their 60-footers and the British and Italians with their 80-footers, the department decided upon 110 feet as the minimum length for military efficiency and the maximum length for greatest production in the yards of motorboat builders throughout the country. Thirty-two boat builders located on the Atlantic Coast, Gulf of Mexico, Mississippi River and Great Lakes, together with four navy yards on the Atlantic Coast and two on the Pacific Coast, contributed the 341 submarine chasers constructed for our own navy and the 100 delivered to the French Government.

When the question of type, speed and general dimensions of hull had been decided upon, the Bureau of Construction and Repair under Rear-Admiral D. W. Taylor, U. S. N., assisted by Commander J. A. Furer, U. S. N., and Lieutenant-Commander A. Loring Swasey, U. S. N. R. F., assumed the task of working out the hull details.

Fig. 1.—United States Submarine Chaser Fully Equipped Ready for Service

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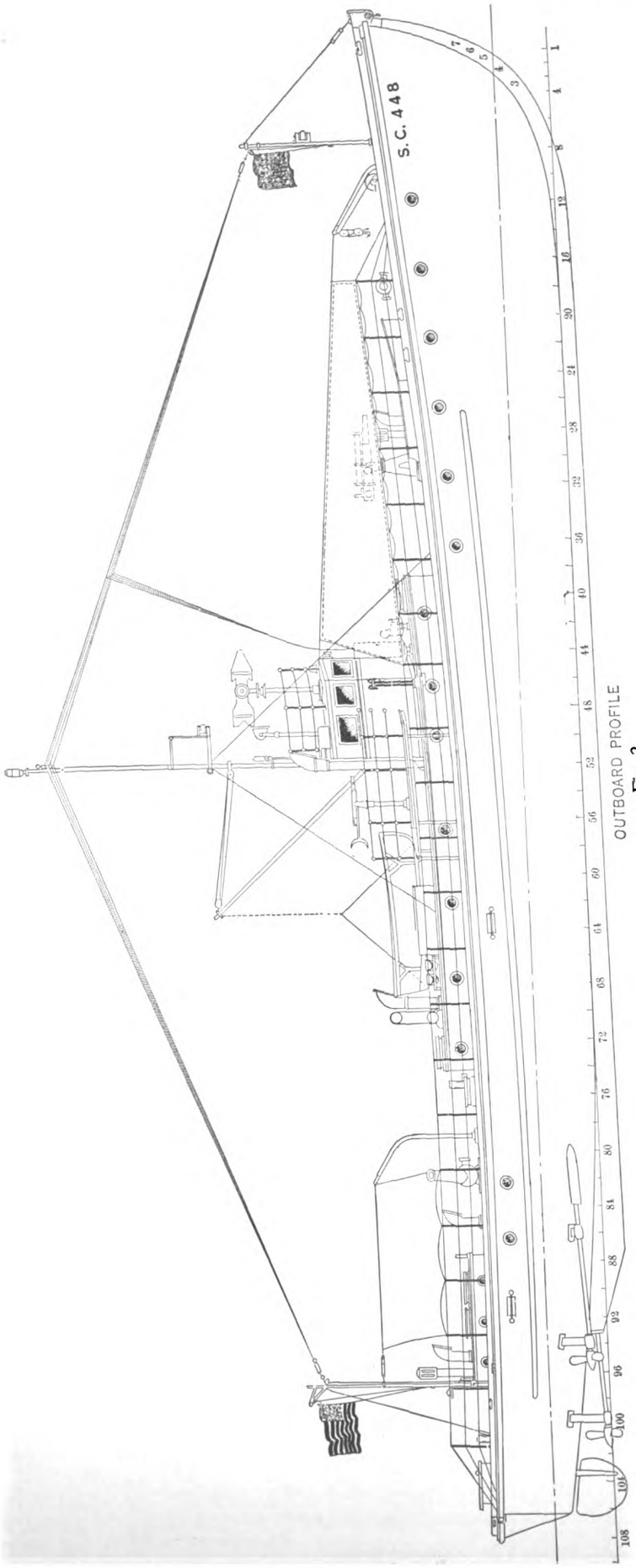

Fig. 2

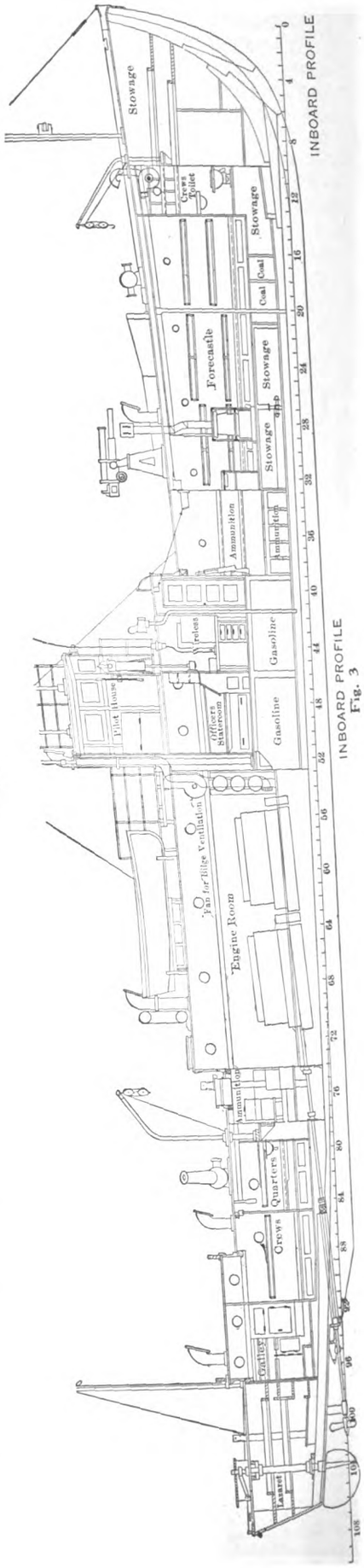

Fig. 3

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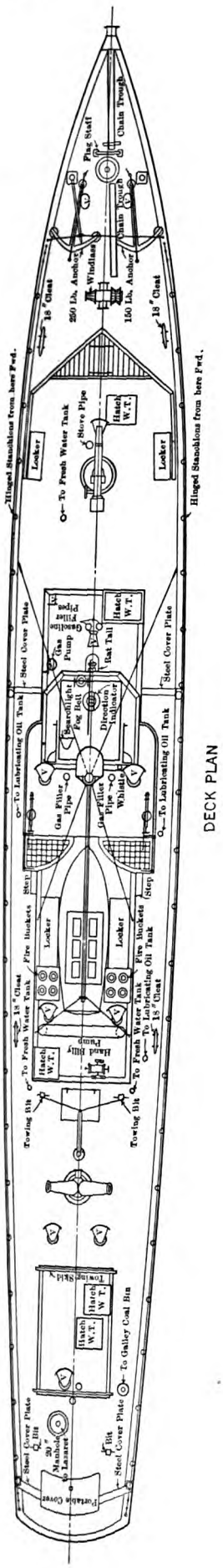
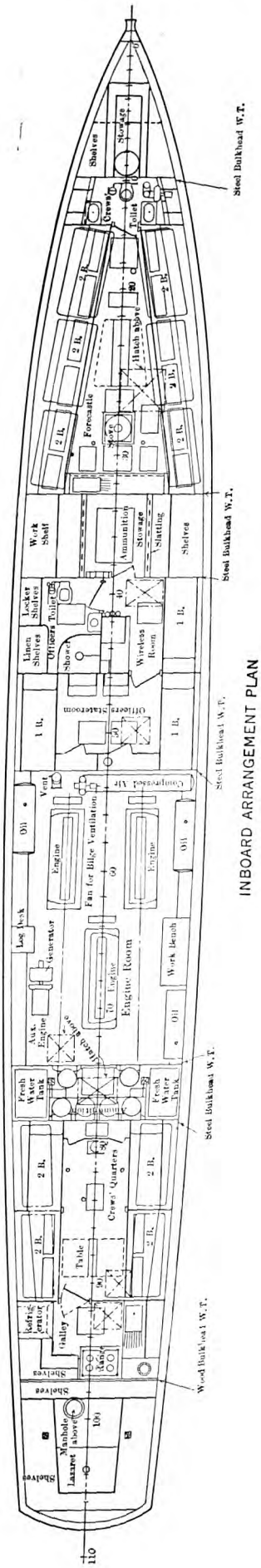


DECK PLAN

Fig. 4



INBOARD ARRANGEMENT PLAN

Fig. 5

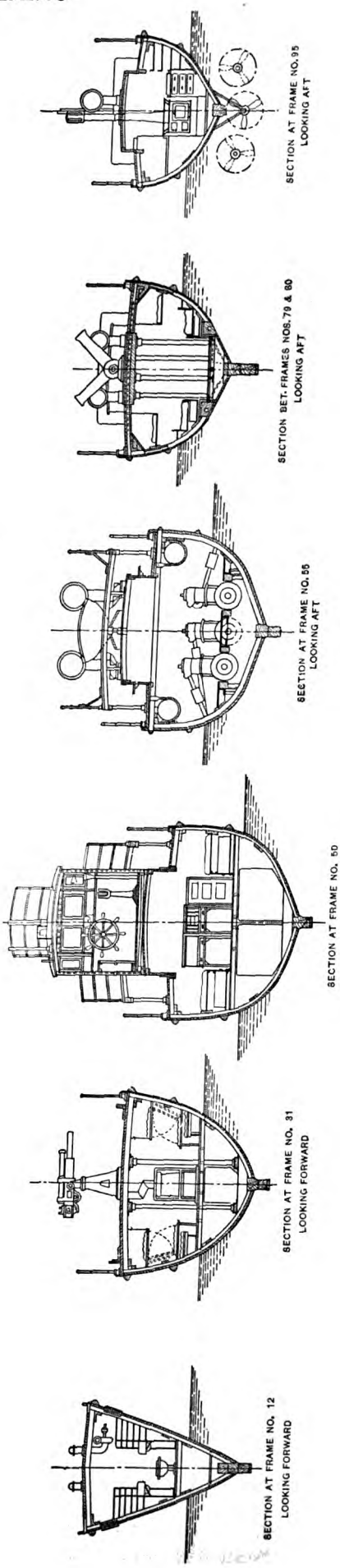


Fig. 6

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The Bureau of Steam Engineering, under Rear Admiral R. S. Griffin, U. S. N., and Commander J. O. Fisher, U. S. N., turned its attention to the problem of supplying suitable machinery equipment.

Steam turbine drive was considered but soon discarded in favor of the gasoline (petrol) engine on account of excessive weight and space required for the former, and also because practically the entire output had been assigned to destroyers. The original layout called for a twin-screw arrangement, but, in order to provide sufficient power to attain the emergency speed specified by the General Board, the three-engine triple-screw arrangement was finally adopted.

When the bids for machinery were opened it was found that most of the engines of sufficient horsepower offered were of the high-speed type. On account of the extremely heavy work to be required of these little vessels and the long periods at sea in all kinds of weather, the slow-speed heavy-duty type was the only one considered suitable by the department.

Another factor that had to be considered in the choice of motive power was rapidity of production. The distribution of contracts for 355 chasers among thirty-eight different yards all prepared to start work at once meant that an immense number of engines would have to be delivered over a short period of time. The Standard Motor Construction Company, Jersey City, N. J., was just completing the contract for two-engine equipments for the 550 British "M. L.'s" built by the Elco Company in such a remarkably short time. The proposition was put up to Mr. Eugene A. Riotte, president of the Standard Company, with the result that on March 21, 1917, a contract was signed calling for delivery of the first set of engines in six weeks and a gradually increasing rate of production up to ten complete sets, consisting of three engines, auxiliaries and fittings, per week.

In spite of many difficulties in securing raw materials and finished parts from outside manufacturers this schedule was very closely adhered to. How close is indicated by the fact that the 355th set left the Standard factory in Jersey City on April 11, 1918, 386 days after the signing of the first contract. As soon as delivery of engines was started the Standard Motor Construction Company placed in the field a corps of expert operators to aid in the machinery installations and running of the trials, and it was a common occurrence for three and four telegrams to be received by the Navy Department in one day, each announcing the completion of another of the small warships.

General Dimensions of the 110-Footers

The following table gives the general dimensions of the vessels:

Length overall	110 feet
Length between perpendiculars	105 feet
Breadth, extreme over guards	15 feet 4¾ inches
Draft, extreme from load waterline	5 feet 11 inches
Displacement for 5 feet 3 inches mean draft	75 tons
Freeboard, minimum to load waterline	3 feet 11 inches
Extreme height, mast above load waterline	38 feet 2 inches
Extreme height, pilot house above load waterline	14 feet 8 inches

Designed with seaworthiness as of prime importance, the little vessels have proved the wisdom of their designers. Four watertight steel bulkheads, one watertight wooden bulkhead, and two non-watertight steel bulkheads divide them into eight compartments.

Strength with minimum weight marks their construction throughout. Steam-bent white oak frames are spaced twelve inches apart except in the engine compartment, where they are doubled. Keels are of yellow pine and oak; bilge stringers, hogging girder, shelf, clamp and sister clamp are all of yellow pine, and these are tied together with the seven bulkheads to give great longitudinal strength. Long leaf yellow pine is used for planking, and decks are of Port Oxford cedar or Oregon pine, with white oak and yellow pine deck beams. Stems and stem knees are of white oak. Transoms are planked on the outside with mahogany, on the inside with cedar or white pine, and framed and stiffened with white oak.

The foundations for the 3-inch anti-aircraft gun forward and the depth-charge projector or "Y" gun aft are heavily reinforced with steel diagonals, plates, web-frames, wood-blocking and heavy pipe stanchions.

The engine foundations are extremely heavy, and one noticeable feature of these vessels is the absence of vibrations at all speeds.

General Arrangement

A watertight steel bulkhead at frame No. 10 separates the forepeak stowage space from the forecastle which runs to another steel bulkhead at frame No. 33. The forecastle has living accommodations, including pipe berths, stowage space for clothing, mess tables, etc., for fourteen members of the crew. In here is also the boiler of the hot water system for heating the vessel, and in the forward end is the crew's toilet.

Aft of the forecastle is the forward ammunition locker with racks for stowing the three-inch ammunition and a small arms rack on the after bulkhead. The submarine-detecting devices and other special equipment are also located in this compartment, which communicates directly with the radio room. The latter room is on the starboard side and contains the ½-kilowatt wireless telegraph set, radio telephone set and living accommodations for the operator. Opposite the wireless room is the completely equipped officers' toilet, a unique feature of which is the shower bath with hand-operated pump. Aft of these two rooms, and separated by a wooden bulkhead is the officers' stateroom. This is equipped with spring bunks, desks, mess table, closets and lockers for the two commissioned officers. A hatch gives access to the pilot house directly above.

In the pilot house, in addition to the usual binnacle and other navigating instruments, are the radio telephone, plotting board for plotting the bearings of enemy submarines, as reported by the "listeners" on the various chasers, running and signaling light control switches and push buttons for operating the general alarms and depth bomb dropping signals. Speaking tubes connect with the crow's nest, engine room, radio and listening rooms and the officers' quarters, so that in time of action the commanding officer is in complete control of all parts of his vessel.

Under the officers' quarters and wireless room are the four 600-gallon gasoline (petrol) fuel tanks. The tanks are not interconnected, and only the two after tanks are piped to the engine float boxes, but a manifold and motor-driven pump are provided for transferring fuel from the forward to the after tanks. Filling pipes and air vents are led to the deck. Reach rod extensions to the main fuel stop valves are also brought to the deck just abaft the pilot house, so that in case of fire in the engine room the gasoline (petrol) supply may be cut off from the deck.

A watertight steel bulkhead separates the officers' stateroom from the engine room, and the other two watertight steel bulkheads are between the engine room and after ammunition compartment, in which are the depth charges

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and fresh water tanks, and between this compartment and the after quarters for petty officers and engine room force. Next in order come the galley and lazarette.

A feature that impresses the visitor to these vessels is their compactness without being cramped, and nowhere is this more apparent than in the engine room. In a compartment approximately 21 feet by 14 feet are located three 220-horsepower Standard main engines and all auxiliaries, switch boards, batteries, oil and air tanks, work benches, etc., and yet there is no cramping at the control stations and there is plenty of space about the engines for inspection and repair. The two wing engines are in the forward end of the compartment so that there may be plenty of space around the control stations, which are at the after end of each engine. By each engine is hung a lubricating oil tank, and on the forward bulkhead are the air tanks, fuel transfer pump and blower for clearing the bilge of fumes.

In the after end of the compartment on the port side are the auxiliary engine, battery charging rheostat and the switchboard controlling all electrical circuits. On the starboard side is a work bench with tool rack above and the two sets of storage batteries underneath. Tachometers and revolution counters for each shaft are on the after bulkhead.

Headroom is ample throughout the compartment. Two 10-inch ventilators, with cowls, at each end of the compartment, a large skylight in the rook of the trunk and numerous portholes afford sufficient ventilation.

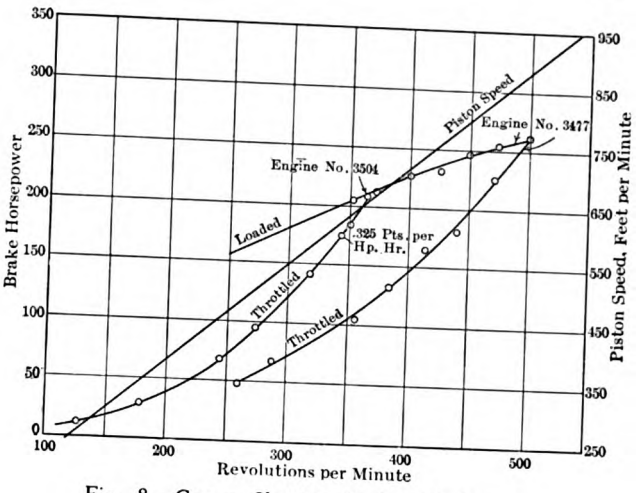

Fig. 8.—Curves Showing Engine Performance

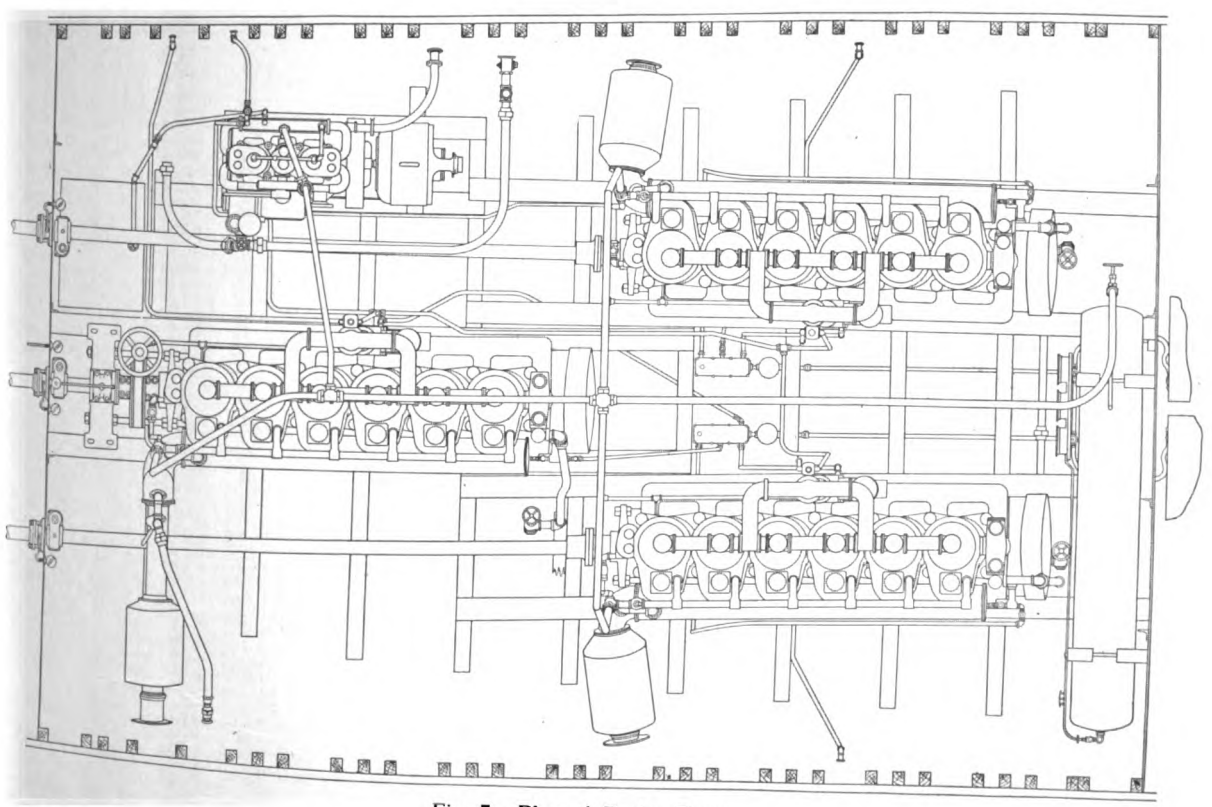

Fig. 7.—Plan of Engine Room

ENGINES

The main engines themselves deserve no little comment. Of the slow-speed, heavy-duty type, they have stood up admirably under the service required by 3,000-mile voyages across the Atlantic, months of patrol and convoy duty in all kinds of weather, and none too expert handling by inexperienced machinist mates, most of whom were of the Naval Reserve Force, to which they have been subjected.

Rated to develop 220 horsepower each when turning 460 revolutions per minute, they are described as of the vertical, inverted, single-acting, four-cycle type, with six cylinders, 10-inch bore by 11-inch stroke. The crank cases are open and the cylinders are mounted on steel stanchions amply crossbraced, the whole set on a heavy cast iron base. The total weight of each engine is about 6,300 pounds.

The cylinders are cast singly, amply water jacketed and the cylinder heads are removable. The engines are coupled directly to the propeller shafts, reversing being accomplished by fore and aft shifting of the valve cams and shaft, throwing into operation the proper cams for ahead or reverse, as the case may be.

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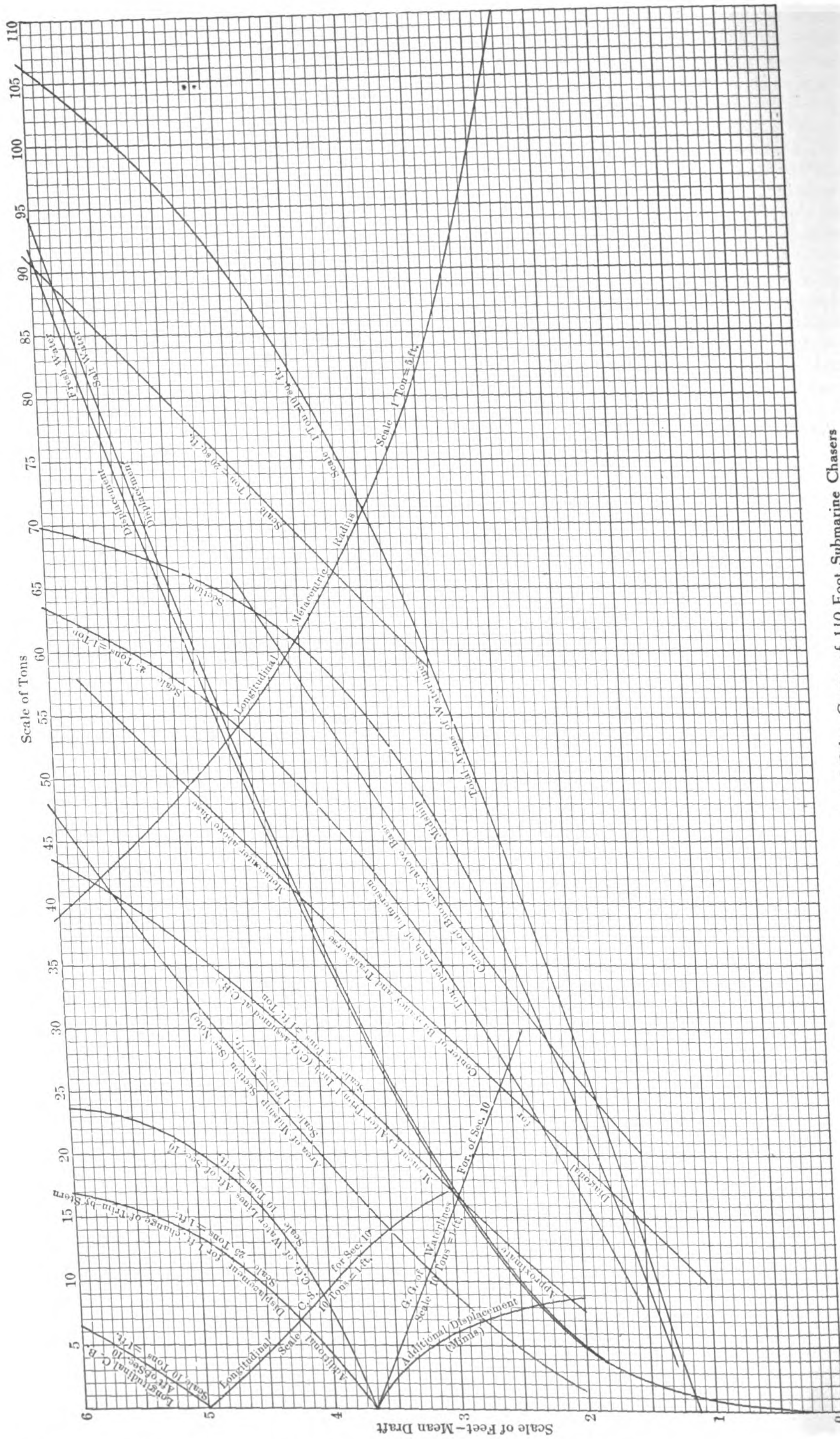

Fig. 9.—Displacement and Other Curves of 110-Foot Submarine Chasers

Note.—The above areas are exclusive of that portion of the keel below the base line of calculations

Starting is accomplished by compressed air entering into the six cylinders through valves operated by cams. A reverse lever with five positions, neutral, starting and running ahead and starting and running reverse, shifts the cams. All controls, ignition switch, throttle, spark control, air-starting valve and reverse lever are brought

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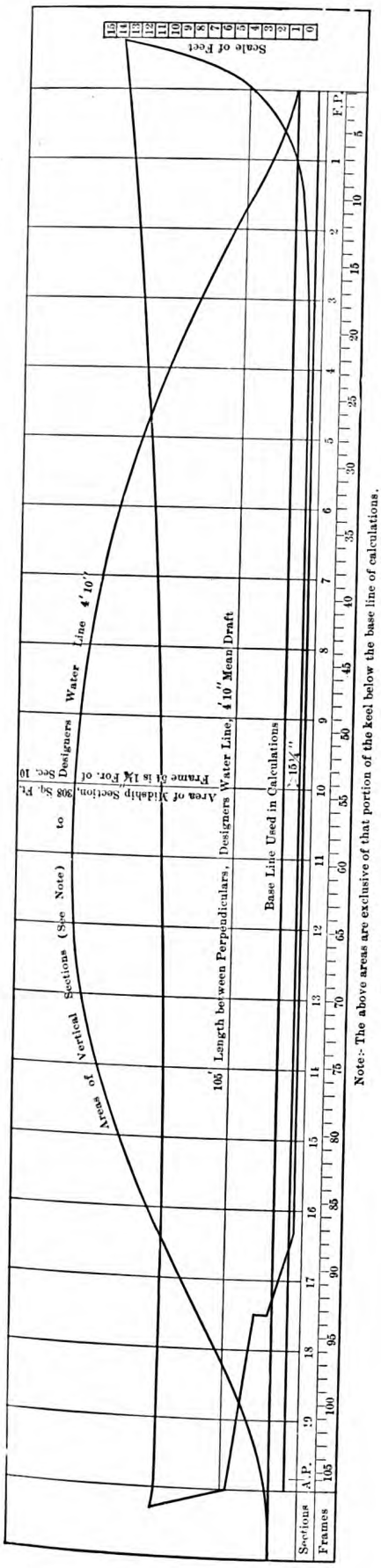

Note: The above areas are exclusive of that portion of the keel below the base line of calculations.

Fig. 10.—Curve of Areas of Vertical Sections

to a control station at the after end of each engine, and the bridge telegraph dial is conveniently located in view of the operator and within easy reach for answering signals.

The ease with which these vessels may be handled and the reliability of the air-starting and reversing features may be appreciated by an examination of the trial reports. The reversing test applied to all boats consisted of bringing the boat to full speed on all three engines and then ringing "full speed astern" on the wing engines and "stop" on the center. The average time for bringing the vessel to a dead stop was twenty-one seconds, and in a distance of a little over two boat lengths. Telegraphs were then rung to "full speed ahead" and the three engines were firing in from two to four seconds.

Ease and Reliability of Control

That these results are achieved in actual service with Navy crews, as well as when the engines are timed for trials and operated by experts, was demonstrated to the writer, who accompanied five chasers from Cleveland, Ohio, to the New York Navy Yard and saw them handled in the twenty-six locks of the Welland Canal and thirty-two locks of the New York State Barge Canal.

Gasoline (petrol) from the fuel tanks forward flows by gravity to the suction side of the piston type fuel pump on each engine, which discharges it directly to the special Standard design vaporizer. Any overflow from the vaporizer fuel chamber is led to a float box and by-pass leading to the pump suction, so that any excess fuel overflow from the vaporizer is immediately taken up by the pump.

Ignition is of the mechanical make-and-break type, with current supplied by magneto for ahead running and by storage battery in reverse.

Each engine has its own circulating pump, air compressor and other auxiliaries.

Auxiliary Engine

One of the hardest worked pieces of machinery in the Navy is the auxiliary engine of the 110-footer. Mounted between the two 4½-inch by 5½-inch power cylinders of the engine is the air compressor for supplying air at 250 pounds pressure for starting the main engines. Directly connected to the engine crankshaft and mounted on the bed plate is the 4½-kilowatt, 120-volt generator, which supplies all electric current used throughout the ship. A gear-driven fire and bilge pump completes the load on this set.

The generator supplies current at 120 volts direct to the motor generator set of the wireless outfit and through a charging rheostat to the two 16-cell storage batteries for lighting, ventilation blowers, searchlight and other electrical apparatus. This set was of ample size when the vessels were first brought out, but as the various submarine-detecting and other devices were perfected they were added to the equipment of the chasers to bring them to that state of efficiency that enabled them to destroy 40 percent of the Hun undersea boats officially credited to United States naval vessels. Each of these instruments increased the drain on the storage batteries, so that the auxiliary engine was soon operating night and day on charging duty.

Additional Charging Units Installed

To relieve the engine of some of this load so that it might have an occasional overhaul and be kept in condition to perform its other duties, the department authorized the installation of ¾-kilowatt Delco charging units on all submarine chasers. These units consisted of a single-cylinder, air-cooled gasoline (petrol) engine direct connected to a ¾-kilowatt, 40-volt generator. At the same time 2⅛-inch by 2½-inch Curtiss air compressors driven by ½-horsepower, 32-volt, 1,750 revolutions per minute motors were installed for emergency use.

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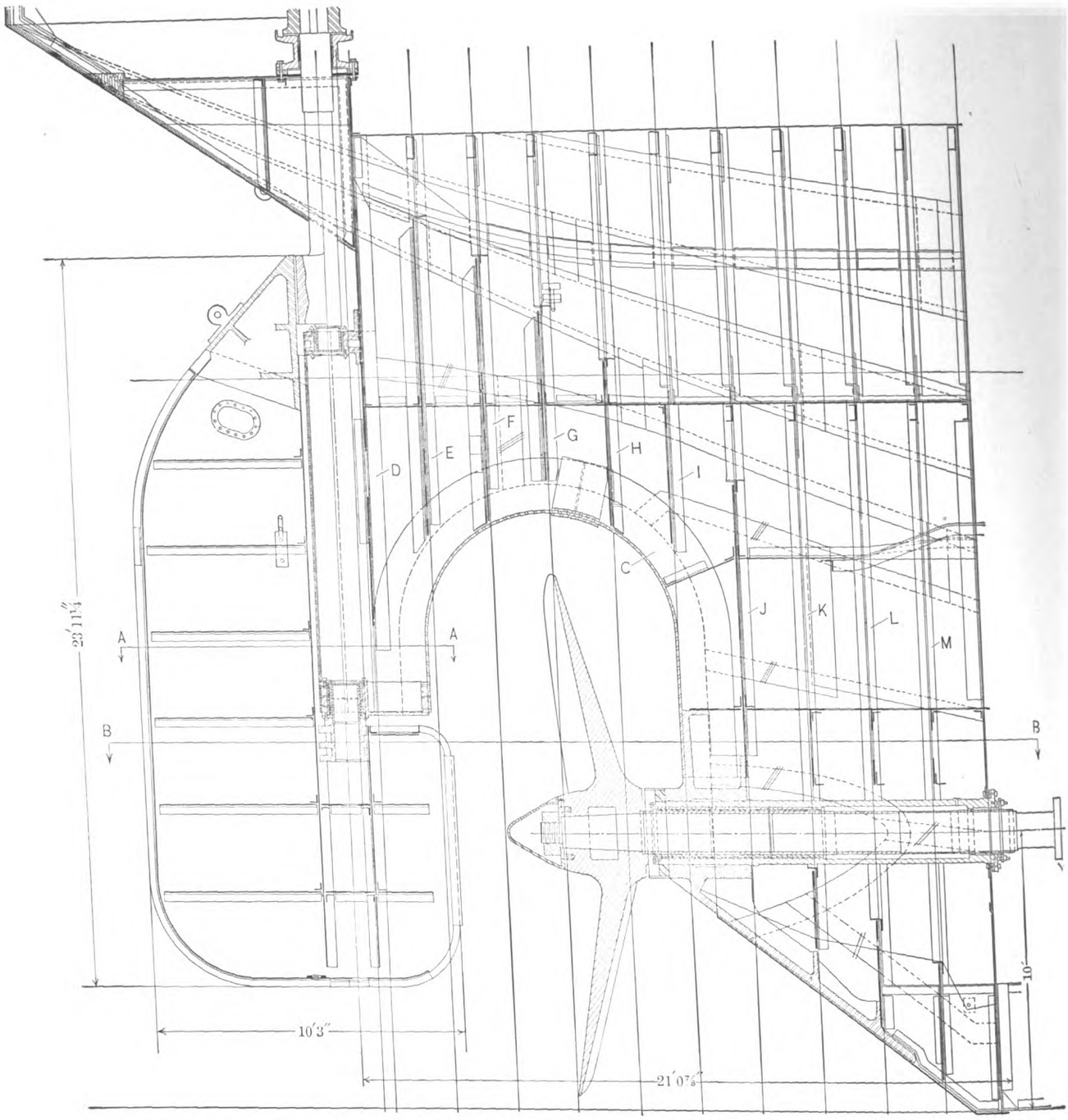
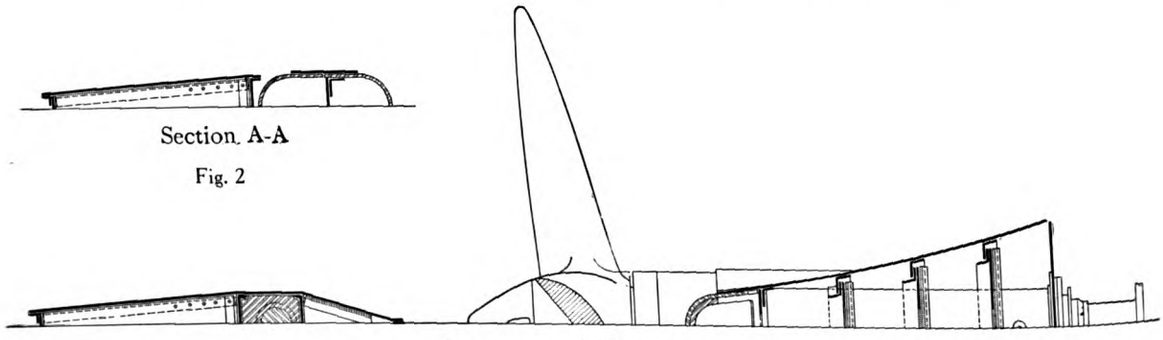


Fig. 1.—Fore and Aft Section Through Stern Frame of "Type A" Hog Island Ship

Section A-A

Fig. 2



Section at 12′ Waterline

Fig. 3

Fig. 4

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Suggestion for Simplifying Construction of Fabricated Stern Frame of Hog Island Ships by Application of Electric Welding

BY WILLIAM T. BONNER

THE fabricated stern construction of the type "A" ships standardized by the American International Shipbuilding Corporation, Hog Island, Pa., offers very great opportunity for the utilization of electric welding.

Fig. 1 shows a fore-and-aft section of the stern portion of the 7,800-ton type "A" ships, showing details of framing and rudder. Fig. 2 represents a horizontal plane section of the fabricated rudder and after end of the plate arch, as on line *A-A*, while Figs. 3 and 4, as assembled, show the co-relative details of the rudder, stern section and under-rudder support at the 12-foot waterline, *B-B*.

As may be noted in Figs. 2 and 3, the hollow construction of the rudder renders it practically buoyant, or would do so were it not for the many rivets, angle bars, corner pieces and other weight members required for its assembly as a watertight riveted structure. For instance, by using 8-inch channels assembled flange inwards for the rim or edge framing members, as in Fig. 5, the weight of material would be greatly reduced and the buoyancy increased not only by the weight reduction but by increased displacement due to turning the channel flanges inward.

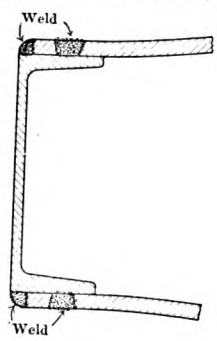

Fig. 5

Similarly, all corner pieces and other like members required for riveting could be eliminated and the frames and plates attached directly to each other by butt or fillet welds.

The greatest saving, however, would be effected by substituting electrically welded construction for the very complicated riveted framing over arch *C* in Fig. 1. Each of the frames *D* to *I*, inclusive, as also the many auxiliary braces and stiffeners, must be heated and hand-hammered to a close-up fit in place, after which they are laboriously secured by drilling and riveting. Because of the very contracted space, all of these operations are necessarily difficult and slow, and therefore expensive.

If, on the other hand, the outer shell plating should be formed and secured in its proper place, the inner framing could be easily added as a two-stage operation. Instead of using angle sections which are difficult to form, the doubling portion could be first shaped to the inner surface of the shell plating and secured by fillet welds along each edge. The second operation would consist in fitting and welding the flange portion against the doubling portion after shearing or burning the jointure edge to conform to the profile of the ship's plating outline.

By this method of construction, all pre-heating and heavy hammer shaping in place would be eliminated, perfect fits would be secured and all perforating of the skin plating would be avoided. There would be no rivets to cause leakage because of constant shear and shaft vibration, and the strength of the structure could easily be made 100 percent efficient.

In like manner it would be found desirable to extend the welded construction to include frames *J*, *K*, *L* and *M* and other like members, the assembly of which is always difficult.

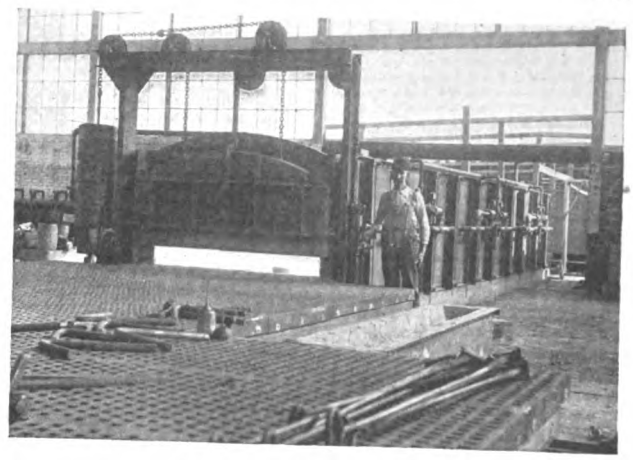
Fig. 1.—Plate and Angle Furnace, Pusey & Jones Yard, Wilmington, Del.

Gas Displaces Fuel Oil in Large Furnaces

BY WILLIAM J. HARRIS, JR.*

THE tremendous expansion of the shipbuilding industry in the United States during the past two years has offered an opportunity for many innovations which a slow, natural growth would never have provided, or which would otherwise have come only after a much longer period of time. Men formerly engaged in other lines of work have entered the shipyards and have brought new ideas with them. In some instances, no doubt, the "innovations" have proved disappointing, but in others the most gratifying results have been obtained.

The use of gas as a substitute for fuel oil in large furnaces is an example of this latter kind. There are now some four or five yards using it on an extensive scale, at least two of which use no other fuel except in the small portable rivet heaters where coke seems to have certain advantages. Gas is also doing this work with equal satisfaction, but has been objected to because of the possible danger from leaks in hose connections. The large furnaces for plate and angle bending and for heavy forgings are of sizes and have burner capacities which the average "gas man" a few years ago would have never considered attempting; and his judgment was perfectly sound, as there was no burner equipment available which had the necessary capacity and efficiency to meet fuel oil on anything like an equal cost basis.

* Engineering Department, The Surface Combustion Company, New York City.

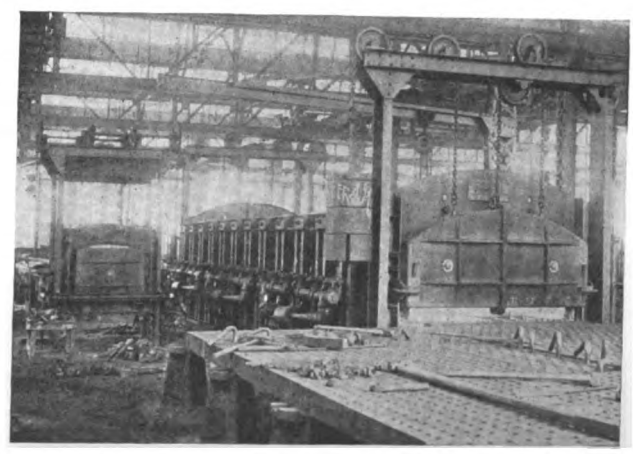
Fig. 2.—Forge Furnace and Angle Furnace, Pusey & Jones Yard, Gloucester City, N. J.

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Fig. 3.—Plate and Angle Furnaces in Angle Bending Shop, Pusey & Jones Yard, Gloucester City, N. J.

The largest shipyard installation of city gas on the Atlantic seaboard is at Gloucester City, N. J., in the New Jersey and Middle Yards of the Pusey & Jones Company, where no other fuel is used for furnace work. The present equipment consists of one 5-foot 6-inch by 50-foot angle furnace, one 7-foot 6-inch by 24-foot plate furnace, one 9-foot by 20-foot plate furnace, one 4-foot by 30-inch liner furnace, one 3-foot 9-inch by 5-foot 7-inch rod furnace for a rivet-heading machine, three 3-foot by 3-foot forge furnaces, one 2-foot by 2-foot forge furnace, one 15-inch by 24-inch tool room furnace, and two rivet heaters serving "bull" riveters. The dimensions given are inside measurement.

No Air Piping or Blower Required

All of this equipment is supplied with gas at a pressure of ten pounds per square inch from a central compressor and meter house. The gas entrains sufficient air for complete combustion by means of proportioning inspirators, which are part of the burner equipment on the furnaces. Hence no air piping or blower is required, and temperature regulation is obtained by the simple adjustment of the gas valve. It is thus possible to connect a furnace to the lines at any point on the system and have it ready for operation by merely turning on the gas. The automatic proportioning feature of the burner equipment insures the maximum combustion efficiency at all times regardless of the skill of the furnace tender.

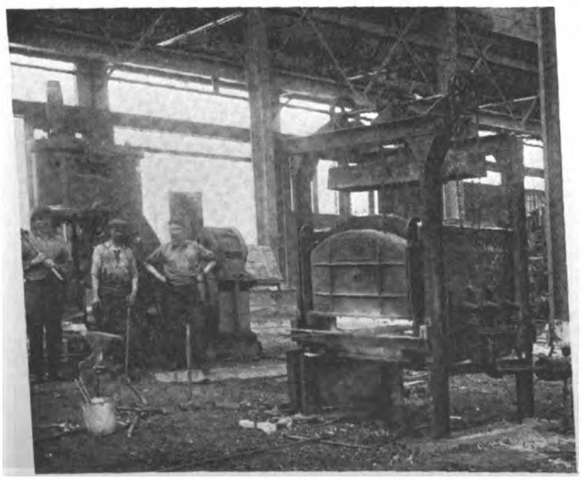

Fig. 4.—Forging Furnace Serving Steam Hammer, Pusey & Jones Yard, Gloucester City, N. J.

The other yard referred to as being completely gas equipped is that of the Pusey & Jones Company at Wilmington, Del., where there is a 6-foot 6-inch by 36-foot plate furnace, a 3-foot by 52-foot 6-inch angle furnace, and a rivet heater for the "bull" riveter.

Comparative Cost of Gas and Oil

The cost of gas in comparison with fuel oil depends not only on the relative cost of the two fuels, but on the efficiency of the oil furnace against which the comparison is made. Actual tests of the oil-fired plate furnace formerly used at the Wilmington yard and the gas furnace which displaced it showed practically the same fuel cost with oil at 6 cents (0/3) per gallon and 600 British thermal unit gas at 57 cents (2/4½) per 1,000 cubic feet. This was in spite of the fact that the gas furnace is 6 feet longer than the oil furnace. Since these tests were made, the price of both fuels has advanced somewhat, but the plant engineers of both yards have stated that even though the gas may cost more than oil the difference is more than compensated for by the many advantages, such as freedom from smoke and fumes, no oil storage or handling, reliability of supply, fuel being paid for after use instead of before, uniformity of temperature distribution and ease of control. The satisfaction given by the gas furnaces is evidenced by the fact that additions have been made in both the plants mentioned, which almost equaled the original installation in size.

The accompanying illustrations are, as indicated by the titles, of the furnaces mentioned above, which were designed and installed complete by The Surface Combustion Company of New York City.

Other Installations

Plate and angle furnaces (the latter being 60 feet long) of similar design using city gas have been supplied by the same company to the Norway Pacific Construction & Drydock Company at Seattle, Wash., and to John Eichleay, Jr., Company and the McClintic Marshall Construction Company at Pittsburgh, Pa., for operation on natural gas.

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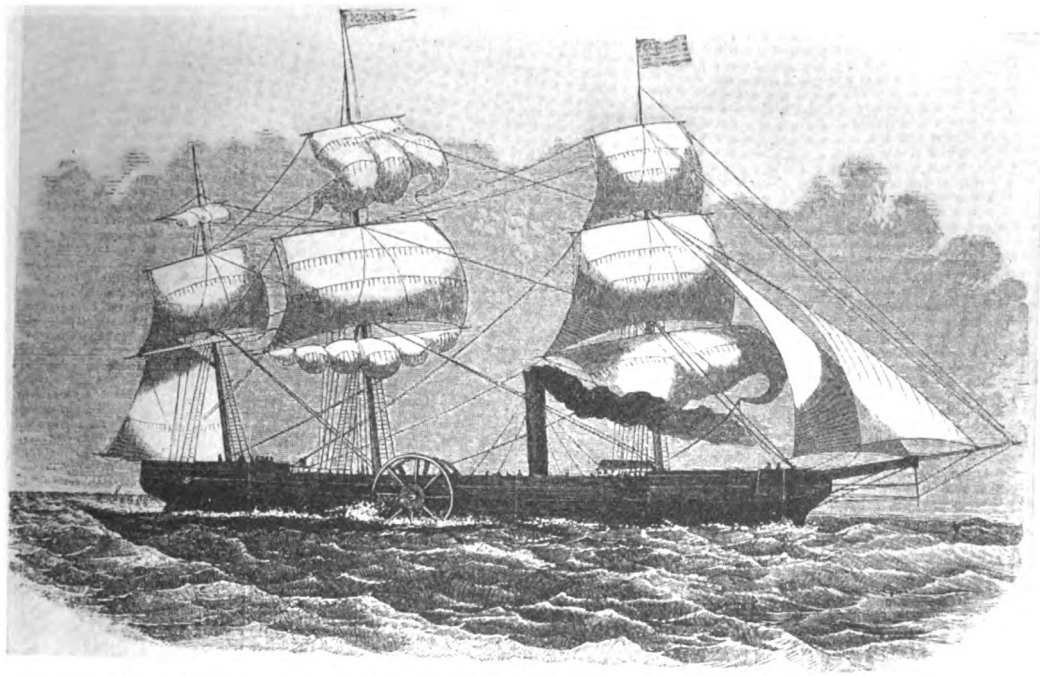

American Steamer *Savannah*, Built in 1819, the First Steamship to Cross the Atlantic

Centenary of Transatlantic Steam Navigation

History of the First Steamship to Cross the Atlantic—Famous Voyage of the American Steamer Savannah to Liverpool in 1819

BY F. B. C. BRADLEE

THE honor of first navigating the sea with a steamer belongs to Colonel John Stevens, of New York, and the credit is not diminshed by the fact that he was forced to it by circumstances beyond his control. Having built the steamboat *Phœnix*, he was prevented from navigating the Hudson, because at that time (1808) Fulton and Livingston had a monopoly of this river, and accordingly the *Phœnix* was sent around by sea to the Delaware River. England in those days was very active and ambitious in the new enterprise, yet it was nine years later before she ventured on sea voyages. In 1817 the steamer *Caledonia* first crossed the Channel on her way to Holland.

Transatlantic steam navigation was long discussed before anyone combining sufficient skill with courage and a spirit of adventure made the bold attempt.

The *Times* (of London, England), in the issue of May 11, 1819, thus announces the expected event:

"Great Experiment.—A new steam vessel of 300 tons has been built at New York for the express purpose of carrying passengers across the Atlantic. She is to come to Liverpool direct."

On the very day that this brief notice appeared, the vessel referred to was visited by the President of the United States and made a short trial trip previous to her departure on a hazardous voyage.

New York Shipbuilders Built the Savannah

This steamer, named the *Savannah*, the first that crossed any of the oceans, was built at Corlear's Hook, New York City, by Crockett and Fickett. The New York custom house records give her measurements as follows: Tonnage, 319; length, 98½ feet; beam, 26 feet; depth of hold, 14½ feet. The *Savannah* was equipped with an inclined, direct-acting, low-pressure engine of 90 horsepower. It had a single 40-inch cylinder; the machinery was built by Stephen Vail at Morristown, N. J., and the boiler by Daniel Dod at Elizabeth, N. J.

Originally intended for a New York and Havre packet, the *Savannah* was purchased before completion by Scarborough and Isaacs, merchants of Savannah. She was launched August 22, 1818. She could carry only seventy-five tons of coal and twenty-five cords of wood. Commanded by Captain Moses Rogers, and navigated by Stevens Rogers, both of New London, Conn., the *Savannah* sailed from the city of Savannah, Ga., on May 25, 1819, bound for St. Petersburg via Liverpool. She reached the latter port on June 20, having used steam eighty hours out of the twenty-six days, and thus demonstrated the feasibility of transatlantic steam navigation.

Original Log-Book of the Savannah the Property of the National Museum

The original log-book of the *Savannah*, containing the daily record of her memorable voyage, is in possession of the United States National Museum.

There are no original pictures extant of the *Savannah*. A crude lithograph is the basis of all the pictures published of this historic vessel and is here reproduced. It is to some degree faulty, but is the best that can be had. Some authorities, notably the late S. W. Stanton, maintained that her paddle wheels were not open, but had canvas paddle boxes. There exists an oil painting showing the *Savannah* so fitted. The question, however, is doubtful. On one page of the Log occurs the statement: "We took the wheels in on deck in 30 minutes." This statement refers to the fact that the steamer was so constructed that

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in case of boisterous weather her paddle wheels could be brought in on deck.

According to the Log the steamer reached Savannah from New York on April 6, having used steam four days. It remained there eight days and then "got steam up and started for Charleston," which was reached next day. The vessel lay at Charleston until April 30, when it returned with steam to Savannah.

The *Savannah* remained twenty-three days at the city of the same name, and on May 11 was visited by the President of the United States.

The *Savannah* was fitted with accommodations for passengers, and, although the Savannah *Georgian* advertised her departure some days ahead, no venturesome travelers presented themselves. Crossing the Western ocean by steam was then too much in the nature of an experiment.

The Historic Voyage Across the Atlantic

On May 22, Captain Rogers "got steam up and at 9 A. M. started" on the transatlantic voyage. Nothing of much interest is detailed in the daily records of the log-book, which are, on the whole, rather monotonous. On June 2 they "stopped the Wheels to clean the clinkers out of the furnice, a hevy head sea, at 6 P. M. started Wheels again; at 2 A. M. took in the Wheels."

Land was sighted on June 16, being the coast of Ireland, and on the 17th the *Savannah* "was boarded by the King's Cutter *Kite*, Lieutenant John Bowie."

The log-book here, as elsewhere, is sternly brief, but fortunately we have in Stevens Rogers' own words a fuller account of the amusing circumstances connected with the boarding by the King's cutter. He said, in a communication to the New London (Connecticut) *Gazette*: "She [the steamer] was seen from the telegraph station at Cape Clear, on the southern coast of Ireland, and reported as a ship on fire. The Admiral, who lay in the Cove of Cork, dispatched one of the King's cutters to her relief. But great was their wonder at their inability, with all sail in a fast vessel, to come up with a ship under bare poles. After several shots were fired from the cutter, the engine was stopped, and the surprise of her crew at the mistake they had made, as well as their curiosity to see the singular Yankee craft, can be easily imagined. They asked permission to go on board, and were much gratified by the inspection of this naval novelty."

Two days later (June 20) they "shipped the wheels and furled the sails and run into the River Murcer, and at 6 P. M. come to anchor off Liverpool with the small bower anchor."

These simple words are all that were thought necessary to record the successful termination of the daring venture; not a word of boasting, of congratulation, nor even of thankfulness, does this man of deeds place on record. Fortunately, we have details of the manner in which the steamer was received in the account given by Stevens Rogers already alluded to. He says: "On approaching Liverpool hundreds of people came off in boats to see her. She was compelled to lay outside the bar till the tide should serve for her to go in.

"On approaching the city, the shipping, piers, and roofs of houses were thronged with persons cheering the adventurous craft. Several naval officers, noblemen and merchants from London came down to visit her, and were very curious to ascertain her speed, destination and other particulars."

During the sojourn of the *Savannah* at Liverpool the British public regarded her with suspicion, and the newspapers of the day suggested the idea that "this steam operation may in some manner be connected with the ambitious views of the United States." One journal, recalling the fact that Jerome Bonaparte had offered a large reward to anyone who would succeed in rescuing his brother Napoleon from St. Helena, surmised that the *Savannah* had this undertaking in view.

The steamer remained twenty-five days at Liverpool and sailed for St. Petersburg on July 23, "getting under way with Steam," and "a large fleet of Vessels in company." Captain Rogers touched en route at Copenhagen, where his vessel excited great curiosity, and also at Stockholm, where she was visited by the royal family, or, in the homely language of the log-book, "His royal highness Oscar Prince of Sweden and Norway come on board." (August 28.) While at Stockholm, we find this entry: "Mr. Huse [Christopher Hughes] the American minister and Lady and all the Furran Minersters and their Laydes at Stockholm come on board"—and at Mr. Hughes' invitation made an excursion among the neighboring islands.

On September 5 the steamer left Stockholm, with Lord Lynedock, of England, who was then on a tour through the north of Europe, as a distinguished passenger. On the 9th she reached Cronstadt, having used steam the whole passage, and a few days later she arrived at St. Petersburg. Here she was visited, at the invitation of our ambassador at that court, by the Russian Lord High Admiral, Marcus de Travys, and other distinguished military and naval officers, who also tested her superior qualities by a trip to Cronstadt.

The *Savannah* lingered at St. Petersburg until October 10 and then set sail on her homeward voyage, "in company with about 80 sail of Shiping." She arrived at Savannah Tuesday, November 30. Shortly after, the steamer was taken to the navy yard at Washington. The object of this visit to the national capital was, in the words of another, "to fix her name and exploits in the minds of prominent men from all parts of the United States, in order to lay a foundation for the defense and maintenance of our claim to that distinction which this craft and her daring commander had unitedly wrought out for our nation upon the mighty deep."

Subsequent History of the Savannah

The subsequent history of the *Savannah* can be told in a few words. On account of the great fire in Savannah, her owners were compelled to sell her, the engine was removed and she was purchased to run as a packet between that place and New York, whither she was bound, under charge of Captain Nathaniel Holdredge, when she was lost on the south side of Long Island in November, 1821.

This sketch of the voyage of the *Savannah*, with the extracts from the log-book, establishes beyond a doubt that America deserves the credit of having been the first to apply steam machinery to the navigation of the Atlantic. Many articles on the early history of steam navigation have been written which ignore the claims of the *Savannah* and her enterprising captain.

In fact, when the steamers *Sirius* and *Great Western* arrived in New York Harbor April 23, 1838, twenty years after the exploit of the *Savannah*, they were received with extravagant manifestations of delight; and in an editorial in the *New York Express* of April 24, reference is made to the "unusual joy and excitement in the city, it being almost universally considered as the beginning of a new era in the history of Atlantic navigation." The achievement of the *Savannah* was forgotten, her skillful captain no longer lived to claim his rights, but patriotic citizens protested in the public press against losing sight of the just claims of America.

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Fig. 1.—The Twenty-Eight Shipways at the Newark Bay Yard of the Submarine Boat Corporation

Noteworthy Achievement of the Submarine Boat Corporation

THE Newark Bay shipyard of the Submarine Boat Corporation launched the following ships during the month of March and thereby established a record for the launching of cargo ships: *Wisconsin Bridge, Milwaukee Bridge, Opequan, Bound Brook, Knoxville, Louisville Bridge, Anniston, Chattanooga, Montgomery.*

These vessels are of the "new American type" with a deadweight capacity of 5,500 tons. They are equipped with Westinghouse geared turbines and have a speed of 10½ knots. Steam is furnished by two Babcock & Wilcox marine type oil-fired watertube boilers.

Approximately 27 steel mills, 56 fabricating plants and 200 foundries, machine, pipe, joinery and equipment shops are engaged in the production of the parts composing the ships assembled at Newark Bay.

On September 14, 1917, when the submarine Boat Corporation signed its contract with the United States Shipping Board Emergency Fleet Corporation, the site of the Newark Bay shipyard was a barren strip of Jersey meadow land, and the management of the Submarine Boat Corporation faced the stupendous task of building the plant, arranging for the manufacture of the plates and shapes, propelling machinery and auxiliaries and, when the ship material began to arrive, of constructing the ships.

In spite of all the difficulties encountered, the Newark Bay shipyard to March 31, 1919, had launched 35 ships, representing a deadweight tonnage of 192,500. A large number of the ships have already received their trials and are awaiting allocation to the operating companies.

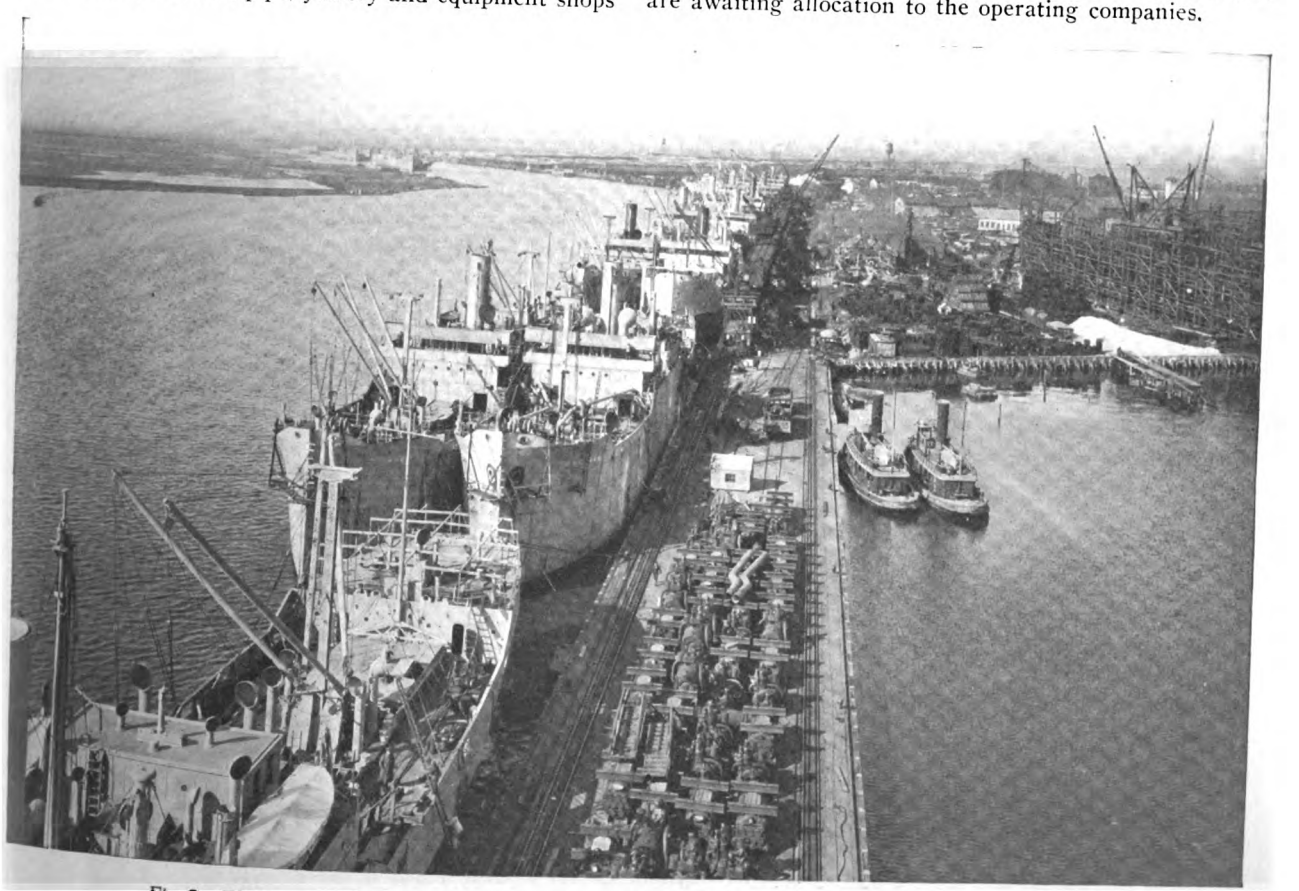

Fig. 2.—Thirteen Vessels Nearing Completion at the Fitting-Out Berth of the Submarine Boat Corporation

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Fig. 1.—The *Schenectady* Afloat

Hog Island Turbine-Driven Cargo Vessel Christened Schenectady

ONE of the geared turbine-driven cargo vessels, which was launched on March 15 by the American International Shipbuilding Corporation at Hog Island, Pa., was christened *Schenectady* in honor of the industrial city where the propelling machinery of the vessel was built. The sponsor was Miss Miriam Rohrer, daughter of A. L. Rohrer, electrical superintendent of the General Electric Company, builders of the turbine and reduction gears installed on the vessel.

The vessel is designed for a deadweight capacity of 7,500 tons, the total displacement loaded being estimated at 11,200 tons. According to estimates, the weight of the steel hull is 3,100 tons; of the machinery with water, 460 tons; of the wood and equipment, 140 tons, and the total weight of the ship, light, 3,700 tons. There are 380,000 cubic feet of cargo space, and the gross tonnage is estimated at 5,400.

Fig. 2.—Launching the *Schenectady*

Propulsion is by single screw, driven by a General Electric marine type geared turbine of 2,500 shaft horsepower, supplied with steam at 200 pounds per square inch pressure from three oil-fired watertube boilers, with a total heating surface of 9,075 square feet, operated under natural draft.

The main turbine is designed to operate at 3,234 revolutions per minute, driving the main propeller shaft through a double-helical, double-reduction gear at a speed of 90 revolutions per minute. With dry saturated steam at 180 pounds gage pressure at the throttle, a 28-inch vacuum referred to a 30-inch barometer in the condenser, the steam consumption of the turbine, when developing its rated horsepower, is guaranteed not to exceed 12 pounds per shaft horsepower. The vessel has a fuel capacity of about 1,100 tons and, with an estimated fuel consumption of 29½ tons per twenty-four hours, will have a cruising radius of over 10,000 nautical miles.

The turbine is so arranged that the ahead turbine and the astern turbine are carried on the one shaft and in the same casing and consists of five stages for the forward turbine and two stages for the reversing unit. The maneuvering is done by hand and is interlocked in such a manner that it is impossible to open the valve for the astern turbine if the valve for the ahead turbine is not closed, or vice versa.

The turbine and the high-speed pinion are designed to operate at a full power speed of 3,234 revolutions per minute when supplied with steam at 200 pounds pressure and exhausting into 28.5 inches of vacuum.

The high-speed gears and the low-speed pinions have a speed of 425 revolutions per minute, and for the low-speed element the speed is further reduced to 90 revolutions per minute. The total speed reduction from the turbine speed of 3,234 revolutions per minute to the low-speed gear or the propeller speed of 90 revolutions per minute gives a ratio of 35.9 to 1.

The General Electric turbine and the one plane, flexible type, speed reduction gear form a single power unit.

The gear is built up of a number of plates machined to a form which gives them the desired degree of lateral flexibility. These plates are put together, engaging solidly at the hub and also engaging on a narrow edge at the periphery. When so built together they form a solid cylinder which can be spirally cut in the ordinary manner. After cutting, the edge engagements are relieved with a small dividing tool, so that each disk operates independently and is free to deflect laterally under the side pressure which results from its diagonal engagement with the pinion. The parts are so proportioned that this lateral deflection can at no time involve fiber strains which could

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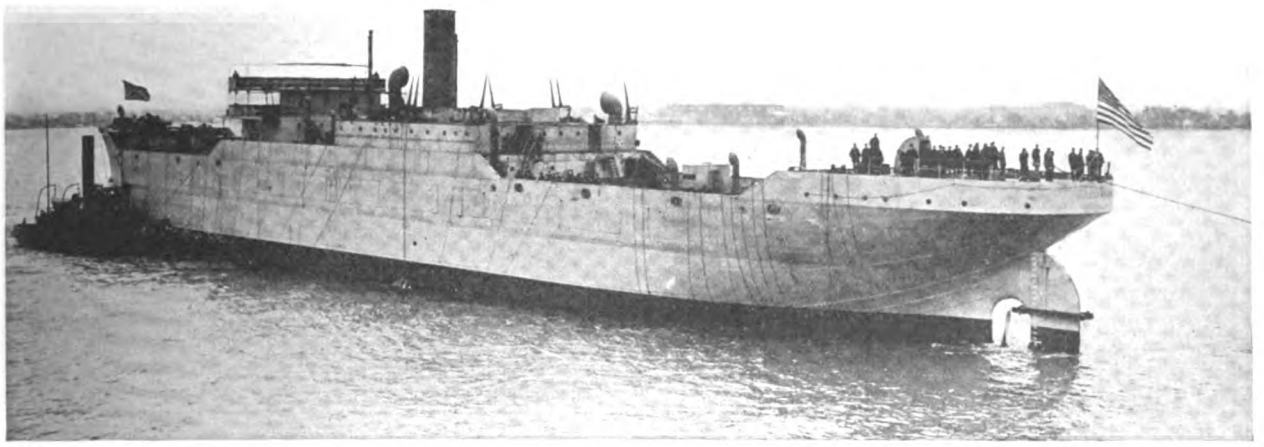

Fig. 3.—Viewed from Any Angle, Little Fault Can Be Found With the Simplified Lines of the Fabricated Hull

possibly cause destructive fatigue and result in failure.

A very small amount of this lateral deflection is sufficient to afford the desired distribution of load, and this amount can easily be given without approaching dangerous periodic strains.

Other electrical equipment on these boats consists of two 15-kilowatt, steam-driven standard General Electric lighting sets, a blinker light controller and an 18-inch direct-current emergency fleet searchlight with pilot house control.

The hull of the vessel is constructed on the transverse system and is subdivided into nine watertight compartments by eight transverse watertight bulkheads, all of which extend to the upper deck. There are four cargo holds, served by five hatches in the upper and second decks and one hatch in the bridge deck.

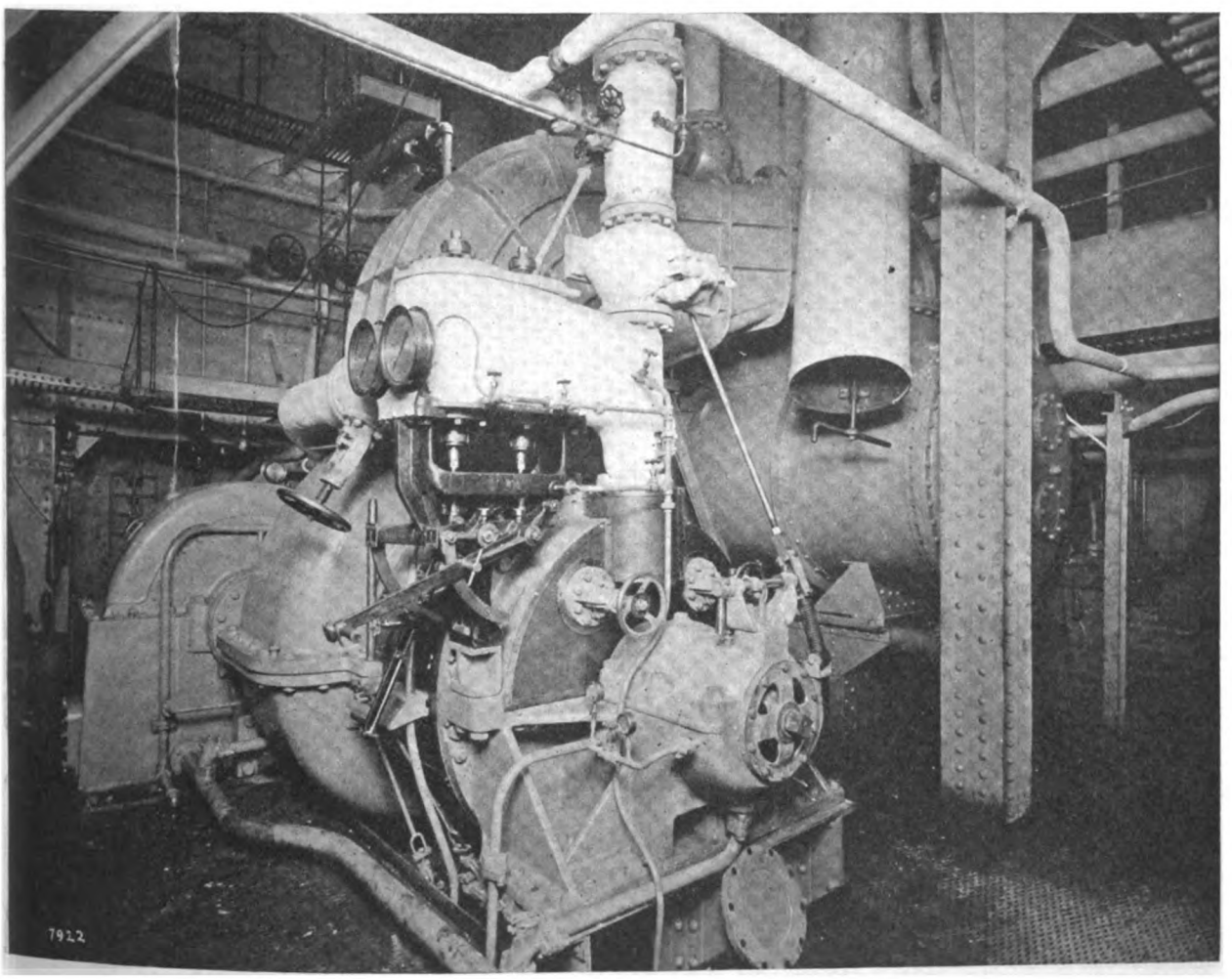

Fig. 4.—View in the Engine Room, Showing the 2,500-Horsepower Geared Curtis Turbine

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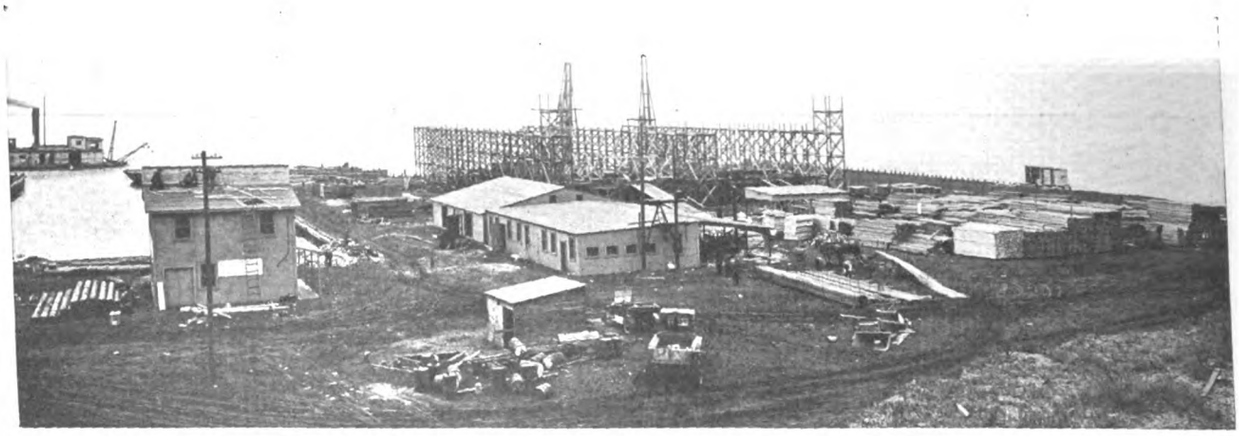


Fig. 1.—General View of the Yard and Shipways of the Liberty Ship Building & Transportation Company

New Concrete Shipyard on Lake Erie

Plant of the Liberty Ship Building & Transportation Company at Cleveland—Method of Constructing Concrete Car Floats

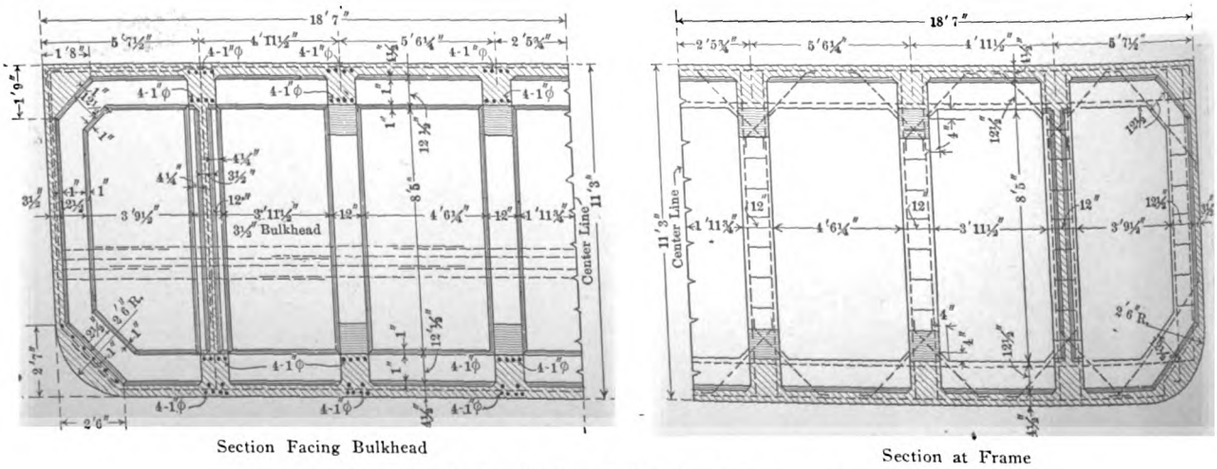
THE yard and berths of the Liberty Ship Building & Transportation Company cover about six and three-quarter acres, with a waterfront of 395 feet at the foot of East 40th street on Lake Erie, Cleveland, Ohio. The yard is entirely on made ground. Timber bulkheads were built along three sides of the yard and filling up to lake level was placed back of same with a hydraulic dredge. A top fill of about four feet was made with excavated material from the bank at the land end of the yard. A top fill of cinders 12 inches thick was spread over the entire area and rolled to grade. The general yard level is five feet above mean lake level.

With this construction, a waterfront on three sides of the yard was obtained. Along the West side, where the water is 16 feet deep, a fitting-out slip 100 feet wide and 325 feet long was built. At present only two berths covering about one-eighth of the entire area of the yard have been built. These are constructed in a substantial and permanent manner and can accommodate the fabrication of large as well as small craft in "end-on" position.

The foundation of the berths is hard wood piling ranging in length from 50 to 60 feet spaced at approximately 5-foot centers over the entire area. The length of a berth is 280 feet and the width 52 feet. The piles are capped with continuous 12-inch by 12-inch timbers across the width of the berths, the cut-off being made so as to give a declivity of 6 percent to the standing ways.

On top of the pile caps, 12-inch by 12-inch yellow pine way blocks were placed to provide for the proper distribution of the weight of the vessel during launching. The entire timber structure was braced both longitudinally and transversely with 3-inch by 10-inch bracing bolted to the pile caps.

The standing ways for the concrete boats now being built were laid down before the forms were placed. Each way is built up of two 12-inch by 12-inch oak timbers bolted together and drifted to the way blocks on top of the caps. A 4-inch by 12-inch oak ribband is bolted on the outboard side to act as a guide or flange for the sliding ways. These ground ways are 26 feet on centers, which brings the make-up block on top of the sliding ways directly beneath a longitudinal bulkhead of the concrete boat now being built. At the dock line the top of the standing ways is at lake level, while at the upper end of the berth



Section Facing Bulkhead

Section at Frame

Fig. 2.—Midship Section of Reinforced Concrete Car Float

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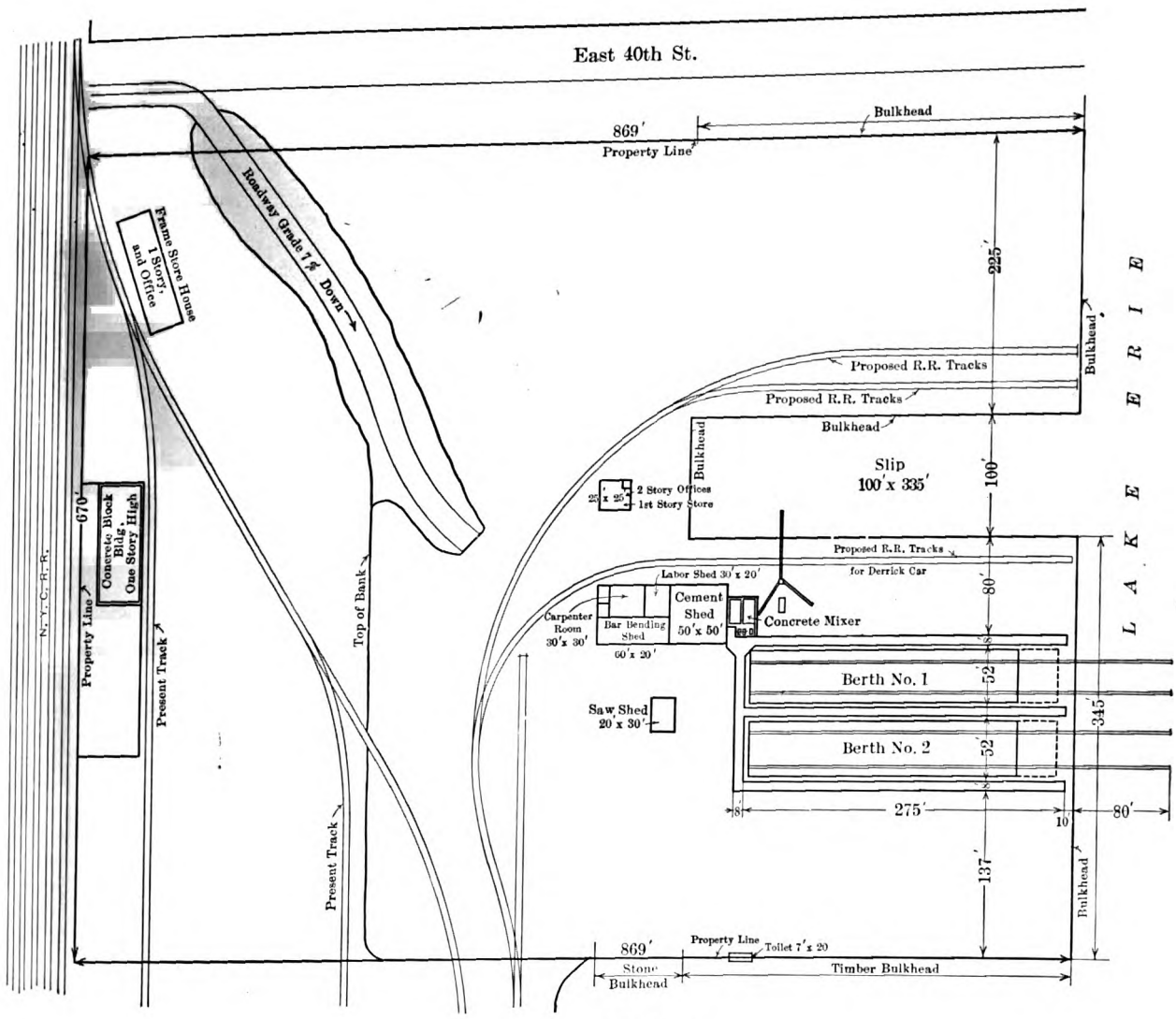

Fig. 3.—Layout of the Yard

they are 16.8 feet above lake level, or 11.8 feet above the general yard level.

On three sides of the berths are timber runways 8 feet wide built on top of timber bents spaced 8-foot centers. The bents are made of 6-inch by 6-inch posts braced with 2-inch by 8-inch timbers bolted to same. The runway itself is composed of removable panels which can be placed at a higher or lower level, according to depth of the vessel being built. Their present level is approximately two feet higher than the bow or upper end of the boat in the berths, which height is 28 feet above the yard level.

These runways, while of a rather unusual type for a shipyard, serve several purposes. They afford a substantial and unmovable frame for bracing hull forms. They will form a framework for future covering of the berths, both for side sheathing and supports for roof trusses and any traveling cranes installed. They are also used for conveying concrete from an elevator to chutes along the side of the vessel being built, as described elsewhere.

Extending 80 feet into the lake are the launching ways, built in substantially the same manner as was used in constructing the berths, with the exception that the ways themselves are bolted to pile foundations instead of being

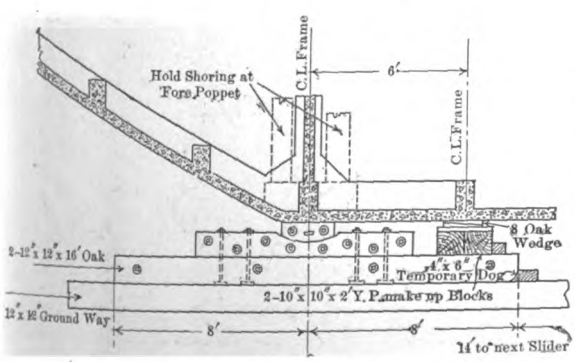

Fig. 4.—Launching Way at Fore Poppet

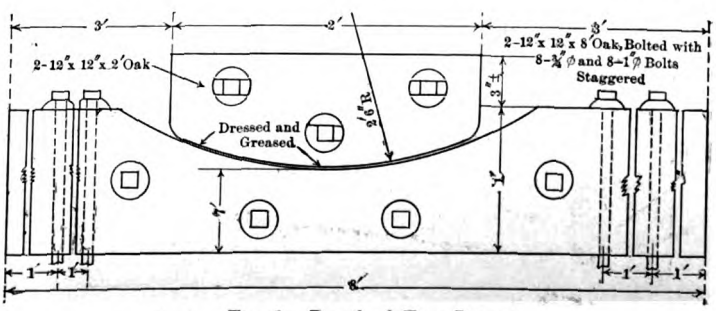

Fig. 5.—Detail of Fore Poppet

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Fig. 6.—Building Berth

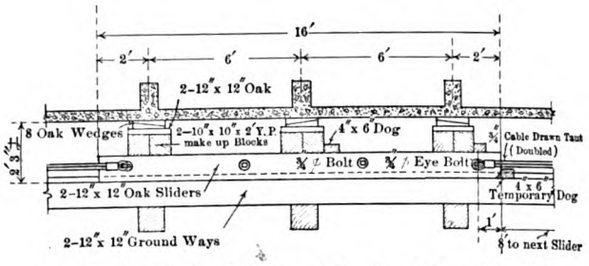

Fig. 7.—Longitudinal Section of Portion of Launching Way

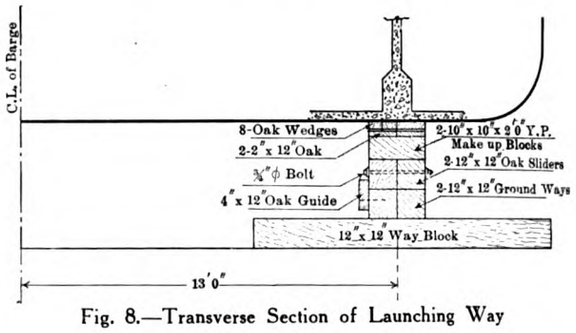
C.L. of Barge
8-Oak Wedges
2-2″ x 12″ Oak
¾″ ⌀ Bolt
4″ x 12″ Oak Guide
2-10″ x 10″ x 2′ 0″ Y.P. Make up Blocks
2-12″ x 12″ Oak Sliders
2-12″ x 12″ Ground Ways
12″ x 12″ Way Block
13′ 0″

Fig. 8.—Transverse Section of Launching Way

fastened with drift pins. There is 4.8 feet of water over the top at the end of the ways, with a total depth of 15 feet of water at this point. These depths are adequate for launching the type of craft now being built.

Access to the yard is obtained by a 20-foot driveway laid on a 7½ percent grade from East 40th street. A railroad switch from the main line of the New York Central Railroad is under construction, and when completed will afford excellent switching facilities, as direct connection can be made to any part of the yard.

The yard buildings consist of laborers' and carpenters' sheds, a cement house, bar-bending shed, and a large carpenter shop with circular saws and other wood-working tools. There is also a concrete mixing plant, including a one-half cubic yard steam-driven Koehring mixer, and bucket elevator. A large boiler plant furnishes steam for mixing and heating concrete materials. A smaller steam boiler runs the concrete hoist. A small air compressor furnishes air for drilling, cleaning forms, cement gun work, vibrating forms during placing of concrete, etc.

The fabrication of the concrete car floats now being built at this yard proceeds as follows: The bottom and outside forms are erected and faired. The reinforcing steel is then put in place supported on small concrete blocks resting on bottom forms. All steel is securely wired or otherwise held rigidly in place. Inside forms are next erected, and when thoroughly braced the concrete is poured. Inside forms are supported by additional concrete blocks resting on reinforcing steel. Concrete is dumped from the mixer into an elevator bucket and raised to the head hopper at the runway level. From this hopper it is conveyed in 6-cubic-foot buggies along the runways and emptied into chutes leading to the point of deposit. The pouring of the concrete is made in three units: First, bottom skin, keelsons and frames and outside skin and frames; second, bulkheads; third, stanchions, deck beams, girders and deck slabs.

The removal of forms takes place as soon as the con-

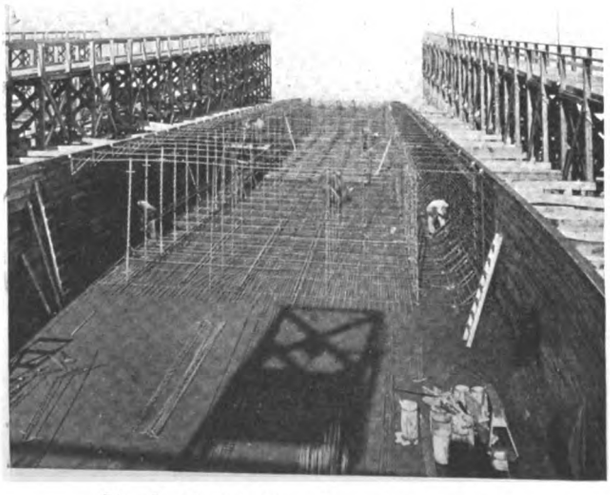

Fig. 9.—Outside Form Erected and Faired

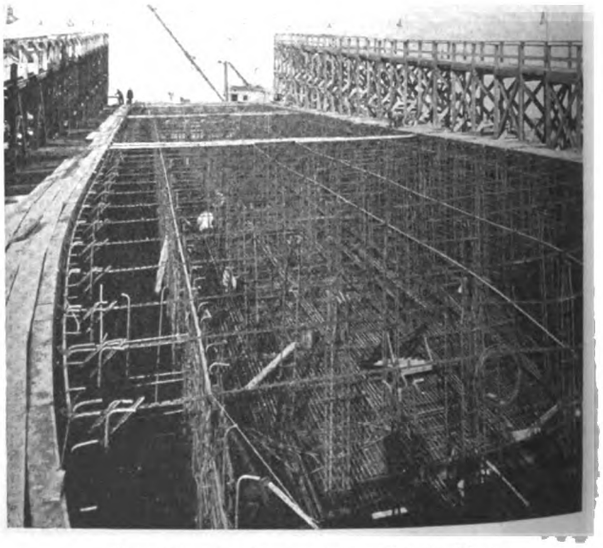

Fig. 10.—Reinforcing Steel Put in Place

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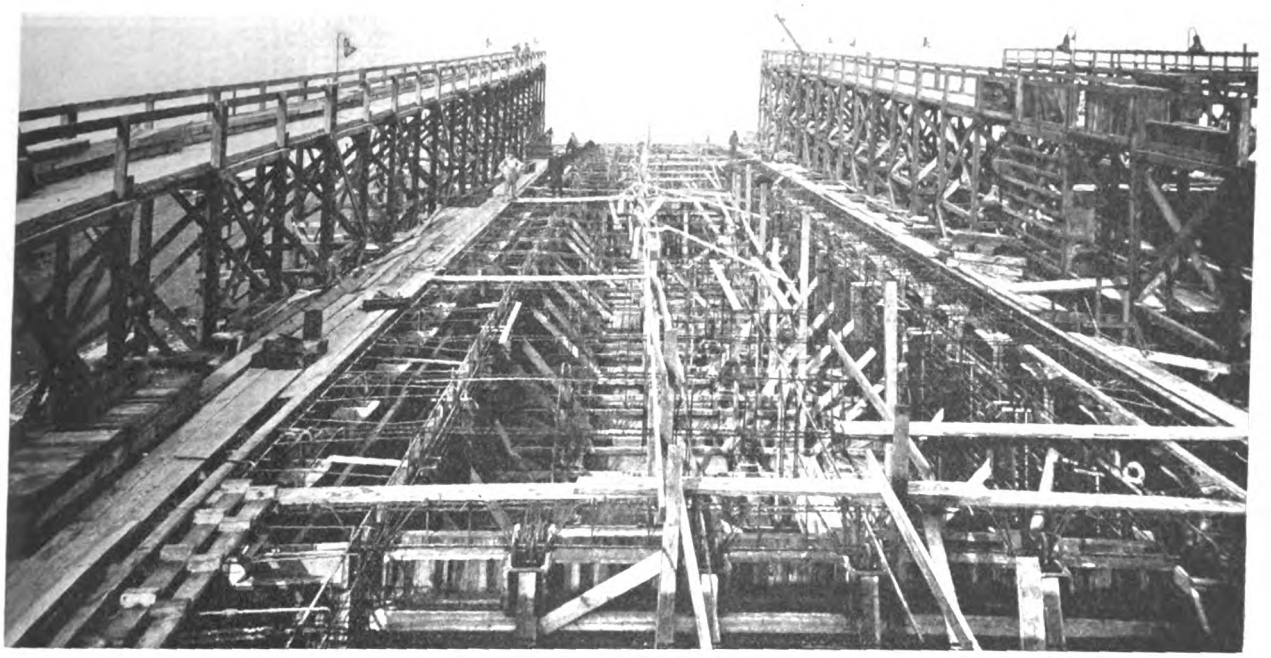

Fig. 11.—Erecting Inside Forms

crete is sufficiently mature, and, as all form work is made in panels, it is the intention to use them at least three times. An interesting detail of construction is the removal of the outside bottom forms for the waterproofing of the concrete hull and the placing of sliding ways underneath. The timbers supporting the bottom forms are in four units placed athwartships. The outboard units are removed first and the side and bilge forms slid back from the concrete about six feet. The outboard panel of the bottom forms is also dropped from the concrete bottom. Waterproofing is then applied to the exposed surface and temporary blocking is placed just inside the bilge curve.

A third unit of supporting timbers is next removed from the bottom and the forms lowered from the concrete. This surface is then waterproofed as before and cribbing and blocking is placed under this part of the boat after waterproofing is completed.

The fourth unit of supporting timbers and bottom forms is finally removed and the bottom treated as before. The entire craft is now carried on blocks and cribs.

The ground ways are next prepared for launching by scraping and coating with a mixture of tallow and soft soap. Sliding ways are then placed in position and make-up blocking set between the concrete hull and sliding ways. All of the sliders are securely dogged to the ground ways before wedging up is started.

When everything is ready for the launching, the weight of the boat is transferred from the cribbing and blocking to the sliding ways by means of lowering and raising wedges. The dogs are then removed from the sliding

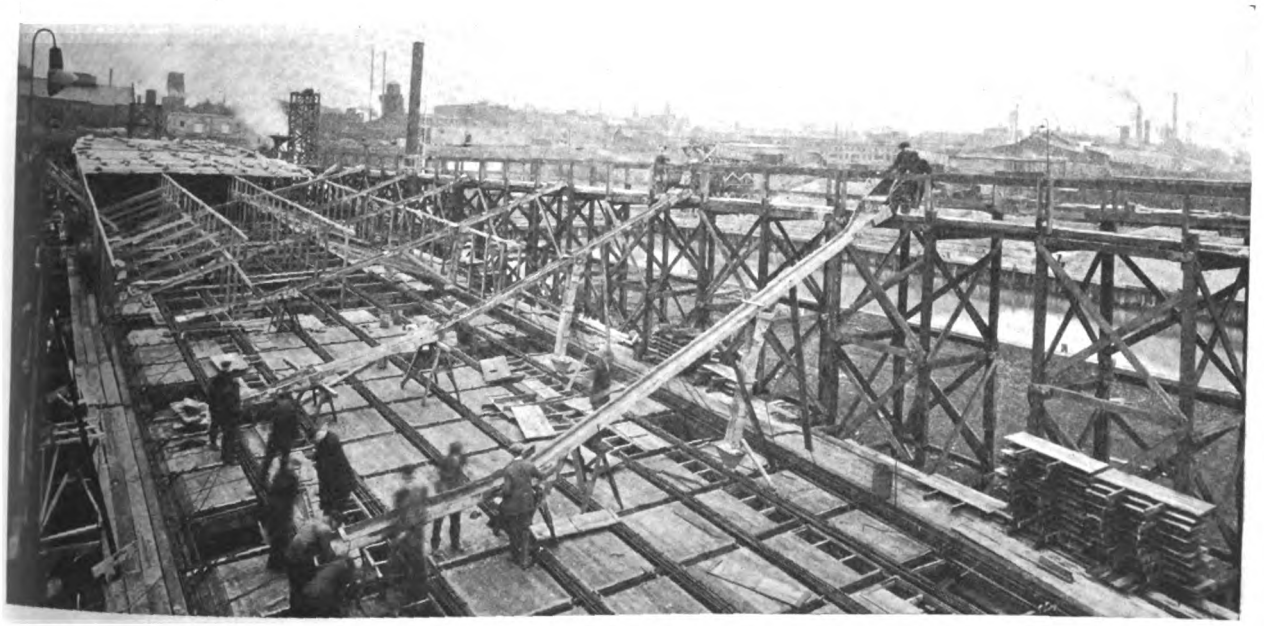

Fig. 12.—Pouring the Concrete

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Fig. 13.—Forms Removed After Concrete Has Set

ways and the anchor ropes attached to the last slider cut. Hydraulic jacks were placed back of the last slider, but were not needed in launching the first two concrete car floats.

In investigating the launching conditions which obtain in the type of concrete craft being built at this yard, it developed that a very great concentrated weight was placed on the last slider (or fore poppet) block at the moment of uplift or when the hull becomes buoyant. In order to overcome the application of this concentrated weight on a pivot point and to prevent a puncture of the concrete shell, a special rocker block or journal was designed and placed under the bottom at the fore poppet. This journal was so designed that as the opposite end of the craft started to lift, the journal block rotated and the concentrated weight was distributed over the area of the block instead of at the pivot point.

Six concrete car floats are now being built at this yard. These are 265 feet long, 37 feet 2 inches beam, and 11 feet 3 inches depth. Their displacement is 1,500 tons light.

London's Tribute to the Mercantile Marine.—On July 19 of this year London is to have an opportunity of paying tribute to the British mercantile marine for its magnificent services during the war—services which kept the British nation from starvation and in other ways aided in the victory. Every shipowner in Great Britain is to be invited to take part, and the ceremony will take place on the historic Thames Embankment.

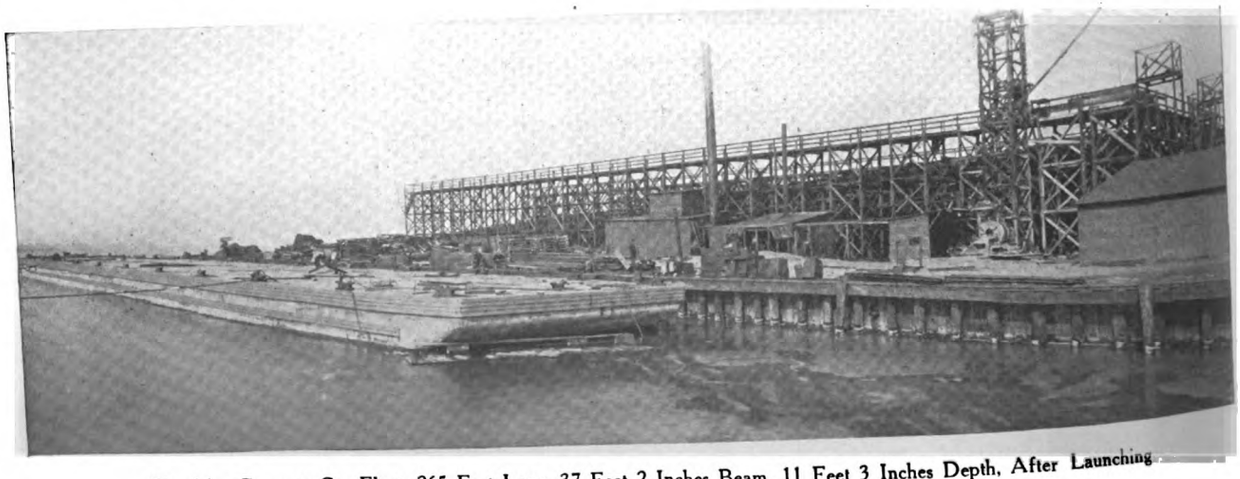

Fig. 14.—Concrete Car Float, 265 Feet Long, 37 Feet 2 Inches Beam, 11 Feet 3 Inches Depth, After Launching

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On the Great Cost of High Speed

Analysis of Relative Costs in Power for Moderate Increases in Speed in Slow- and High-Speed Vessels

BY SIDNEY GRAVES KOON, M. M. E.

THE continual demand for higher speeds of travel, both on land and on sea, has produced a pressure upon the designers of the media of travel which is by no means apparent to the casual observer. In the case of steamships, it is far from an insuperable task to install machinery which will produce any speed yet demanded; but when it comes to the concurrent problem of providing, along with that machinery, enough fuel to operate it at its maximum power for a distance of three thousand miles, and of allowing at the same time for enough carrying capacity for cargo and passengers to make the voyage remunerative, the difficulty of the situation sometimes becomes very great. The importance of the subject would seem to justify a little discussion of the most salient feature in it—the cost in power for the speed required.

During the height of the submarine raiding of commerce in 1917, much criticism was directed at the so-called "standard" designs of the Emergency Fleet Corporation, due to the fact that the speed provided was only 10.5 to 11 knots (actually less than that at sea), while the submerged speed of the more modern of the German submarine was supposed to be a little greater than that. A speed of 12 knots or better was asked of the freighters, that they might have that much better chance of eluding their slinking foes, and immunity had been shown to increase about as the square of the speed.

But the power cost of that increase in speed was shown to be fully 50 percent, or an increase from 2,500 to 3,750 horsepower. At prevailing machinery weights, this represented about 200 tons. To this must be added the extra fuel for the more powerful engines—some 200 tons more; a total added weight of 450 tons when we include the extra feed water, lubricants and stores. Now, this calculation is based on a ship with deadweight capacity of 8,800 tons, or cargo capacity of perhaps 7,500 tons. The loss in carrying capacity, therefore, would have been about 6 percent—a very serious item, when the demand for capacity was as insistent as it was at that time.

This example of the cost of a really moderate increase in speed in a region of low speeds is but a trifle compared with a similar increase in the speed of a ship which is already of high speed, as a passenger ship or cruiser. A particularly good case in point is found in a study of the trial reports of a group of four very successful armored cruisers built some years ago for the British Navy. These ships carried the speed up to a point fully abreast of the most stringent demands for transatlantic practice, if we except such a flyer as the *Mauretania*. They were the *Drake*, *Good Hope*, *King Alfred* and *Leviathan*, of which the two first mentioned were lost in the war.

The ships were substantially identical "from keelson to truck." They measured 500 feet in length, with a beam of 71 feet and draft of 26 feet. The corresponding displacement was 14,100 tons. The designed power and speed were respectively 30,000 horsepower and 23 knots. While it is not certain that the mean displacement on each of the trial runs referred to later was the "normal" 14,100 tons, that is assumed to be the case.

In the powering of ships, the formula almost universally adopted is:

$$H = \frac{D^{2/3} \times V^3}{K}, \qquad (1)$$

where H is the horsepower required, D is the displacement in tons, V the speed in knots, corresponding with H, and K is a so-called "constant" whose value depends upon a variety of considerations, such as the relative fineness of the underwater form of the ship, the relation of length to the other main dimensions and to the speed, and to some extent upon the absolute size of the vessel. In the choice of a proper value for this constant, the designer requires to have before him the results of a large amount of experience, both his own and that of others, and the element of judgment enters to a very large degree. In many cases use is made of model basin experiments to check the power calculated from the formula.

The converse of equation (1) may be written:

$$K = \frac{D^{2/3} \times V^3}{H}, \qquad (2)$$

and is used in analysis, while (1) is used in design. In the present *design*, $H = 30{,}000$, $V = 23$, $D = 14{,}100$, $D^{2/3} = 581$, $V^3 = 12{,}167$, and $K = 253.3$, for the maximum power and speed.

The four ships mentioned had trials at a variety of speeds, and the results of the more important of these trials in speed and power are tabulated in Table I, arranged in order of speed. In each case the corresponding value of the "constant" K, as well as the name of the ship, is given.

TABLE I

Speed	Horsepower	K	Ship
9.52	1,685	298.6	*Drake*
13.06	4,014	323.6	*Drake*
15.17	6,743	301.8	*King Alfred*
15.24	6,481	318.4	*Leviathan*
15.41	6,520	327.1	*Drake*
15.43	6,937	308.7	*Drake*
15.91	7,053	295.2	*Good Hope*
17.93	9,872	345.7	*Drake*
20.03	14,801	316.5	*Drake*
21.6	21,450	273.9	*King Alfred*
21.96	22,900	269.6	*Leviathan*
21.98	22,540	274.6	*King Alfred*
22.08	23,103	271.7	*Drake*
22.1	22,467	280.2	*Good Hope*
22.16	22,534	281.6	*Drake*
23.05	30,557	233.6	*Drake*
23.05	31,088	229.6	*Good Hope*
23.25	31,592	231.9	*Leviathan*
23.465	31,156	241.7	*King Alfred*
24.11	31,409	260.1	*Drake*

To eliminate as nearly as may be the results of accidental disturbances in the trials, such as meeting with unexpectedly heavy weather, etc., the results of the entire series are averaged by means of a smooth curve passed as nearly as possible through the various points representing the individual trials. In this way it becomes reasonable to give the values taken from the curve, and re-

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sultant from this process, a weight which the individual readings would not have, and to base upon them computations which, if resting solely upon the performance of one ship, would be of interest only as pertaining to that one vessel. This curve is shown by the solid line in Fig. 1.

Omitting the single value above 24 knots from the trials of the *Drake*, as being discordant with the remaining results,* the values of horsepower for each knot of

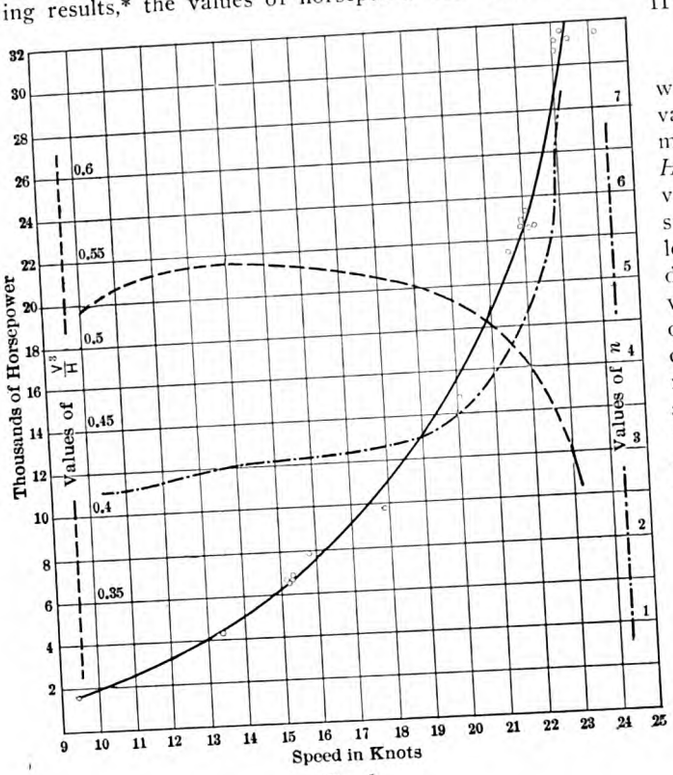

Fig. 1

speed from 10 to 21 are given in Table II, as well as for each half-knot from 21 to 22.5, and for each quarter-knot from 22.5 to 23.25 knots speed. Values of the cube of the speed are also given, as well as of K and of increments in H.

Examining the increments of power, it is at once obvious that the amounts required to increase the speed by one-quarter knot, from 23 to 23.25 knots (2,200 horsepower), is the same as that required for the half-knot from 21.5 to 22 knots; is more than that for the knot from 18 to 19 knots; for the two knots from 13 to 15 knots, and for the three knots from 10 to 13 knots. That there is a rapidly increasing augmentation of power required for relatively slight increases in speed is shown by the fact that the quarter-knot, from 22.5 to 22.75 knots, requires only about two-thirds the increase in power demanded by the quarter-knot from 23 to 23.25 knots.

TABLE II

V	H	K	ΔH	V^3	Log H_2/H_1	Log V_2/V_1	n
10	1,920	302.5	.....	1,000	.....	.....	.....
11	2,500	309.1	580	1,331	.114 944	.041 393	2.779
12	3,200	313.4	700	1,728	.107 210	.037 796	2.835
13	4,050	315.	850	2,197	.102 434	.034 762	2.948
14	5,050	315.	1,000	2,744	.095 866	.032 188	2.98
15	6,225	314.1	1,175	3,375	.090 963	.029 962	3.033
16	7,600	313.	1,375	4,096	.086 716	.028 028	3.094
17	9,170	310.9	1,570	4,913	.081 707	.026 227	3.115
18	10,975	308.6	1,805	5,832	.078 094	.024 814	3.146
19	13,050	305.	2,075	6,859	.075 182	.023 481	3.2
20	15,500	299.4	2,450	8,000	.075 182	.022 275	3.372
21	18,500	290.8	3,000	9,261	.077 004	.021 189	3.636
21.5	20,400	282.9	1,900	9,938	.042 576	.010 216	4.165
22	22,600	273.2	2,200	10,648	.044 540	.009 986	4.461
22.5	25,200	262.4	2,600	11,391	.047 275	.009 762	4.848
22.75	26,700	255.9	1,500	11,775	.025 306	.004 799	5.28
23	28,600	247.	1,900	12,167	.029 789	.004 746	6.282
23.25	30,800	236.9	2,200	12,568	.033 021	.004 691	7.045

* This was made with a new set of propellers; eventually, all four ships, with improved propellers, exceeded 24 knots speed. It will be noted that, in addition to this one point, there are two others from the trials of the *Drake*—those at 17.93 and at 20.03 knots—which represent better results than those on the line of the curve. All of these were obtained with the improved form of propeller.

By taking the consecutive values of H and V in Table II and comparing them by means of the formula for power,

$$H = C\,V^n, \tag{3}$$

where C is an absolute constant and n a variable index, values of this index may be readily obtained. The simplest method consists in taking respectively the logarithms of H_2/H_1 and V_2/V_1, where H_1 and H_2 represent successive values of the power and V_1 and V_2 the corresponding successive values of the speed, and dividing log H_2/H_1 by log V_2/V_1. The result will be the index required. The index thus obtained is applicable only to the particular interval over which it is computed, and has no reference to the other intervals of speed involved; but the results of such a computation show vividly the enormously augmented demands for power as the speeds become high. In Table II are given, in addition to the items previously enumerated, values of these logarithmic quantities covering in each case the speeds immediately adjacent, and also a series of values of n representing the quotient:

$$\frac{\log H_2/H_1}{\log V_2/V_1} = n. \tag{4}$$

Equation (4) is obtained from (3) as follows:

$$H_1 = C\,V_1^{n_1}, \tag{5}$$

and

$$H_2 = C\,V_2^{n_2}. \tag{6}$$

Dividing (6) by (5), we have:

$$\frac{H_2}{H_1} = \frac{V_2^{n_2}}{V_1^{n_1}}. \tag{7}$$

But n_1 and n_2 are not very dissimilar in value. If we write

$$\frac{H_2}{H_1} = \frac{V_2^{n_2}}{V_1^{n_1}} = \left(\frac{V_2}{V_1}\right)^n, \tag{8}$$

it is apparent that n will be some value greater than n_1 or n_2, for, taking all values with subscript $_2$ greater than the corresponding values with subscript $_1$,

$$\left(\frac{V_2}{V_1}\right)^{n_2} < \frac{H_2}{H_1} > \left(\frac{V_2}{V_1}\right)^{n_1} \tag{9}$$

It may be shown, however, that the difference between n, n_1 and n_2 within the narrow limits represented between successive values of the speed is negligible, for, from equation (6),

$$n_2 = \frac{\log \dfrac{H_2}{C}}{\log V_2}. \tag{10}$$

Then

$$n - n_2 = \frac{\log H_2/H_1}{\log V_2/V_1} - \frac{\log H_2/C}{\log V_2} \tag{11}$$

$$= \frac{\log V_2 \times \log H_2/H_1 - \log V_2/V_1 \times \log H_2/C}{\log V_2 \times \log V_2/V_1}. \tag{12}$$

Dividing (12) by (10), we have:

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$$\frac{n-n_2}{n_2} = \frac{\log V_2 \,(\log V_2 \times \log H_2/H_1 - \log V_2/V_1 \times \log V_2{}^{n_2})}{\log V_2 \times \log V_2/V_1 \times \log V_2{}^{n_2}}, \qquad (13)$$

in which the term $\log V_2$ cancels from both numerator and denominator. Substituting in (13) from the first set of values in Table II, and assuming, for the present, that $n_2 = n = 2.779$, we have:

$$\frac{n-n_2}{n_2} = \frac{1.041393 \times .114944 - .041393 \times 2.779 \times 1.041393}{.041393 \times 2.779 \times 1.041393}$$

$$= \frac{.114944 - .115031}{.115031},$$

which gives a negative result. This is due to the fact that the actual value of n_2 is slightly less than that of n, or less than 2.779, and a proper correction would reduce the value of the quantity here represented by .115031 to something less than .114944, and thus produce a positive difference, which should obtain. It is quite evident, however, that $n - n_2$ is so nearly zero as to be wholly negligible. The same may be shown of $n - n_1$ and of $n_2 - n_1$. This establishes the validity of equation (4), from which the values of n given in Table II have been computed.

The "dot-and-dash" curve in Fig. 1 represents graphically the values of n as taken from Table II. It is seen that up to about 18 knots the increase in value is very gradual, and the values are in the neighborhood of 3, but at higher speeds the slope of the curve becomes very abrupt, until at the maximum speed indicated the value of the index exceeds 7.

When a wider range of operations is considered, as, for instance, the value of n between 10 and 20 knots or between 15 and 23 knots, it is obvious that the difference between n and n_2 or n_1 would be somewhat greater than when the intervals are smaller. Assuming, however, the applicability to this purpose of equation (4), Table III has

TABLE III

Range of V	Log H_2/H_1	Log V_2/V_1	n
From 10 to 15 knots	.510 838	.176 091	2.896
" 10 " 20 "	.907 031	.301 030	2.925
" 10 " 23 "	1.173 065	.361 728	3.244
" 15 " 20 "	.396 193	.124 939	3.062
" 15 " 23 "	.662 227	.185 637	3.567
" 20 " 22 "	.163 776	.041 393	3.957
" 20 " 22.5 "	.211 069	.051 153	4.127
" 20 " 22.75 "	.266 034	.060 698	4.388
" 20 " 23 "	.298 219	.065 393	4.564

been constructed, showing the variation of n over several selected ranges of speeds.

From this it is seen that, in general, the wider the range under observation, with the upper limit fixed, the lower will be the value of n, this being especially the case when the range extends down into the lower values of V. Not until the lower limit is pushed up to a high value of V does the value of n approach anything comparable with the high values in the lower half of Table II.

A final analysis, that of the values of $\frac{V^3}{H}$, representing $\frac{K}{D^{2/3}}$, has been made, and the values plotted in the dotted line in Fig. 1. These values are, of course, proportional to K, for $D^{2/3}$ is constant. The falling off of the curve at high speeds is but another indication of the extreme power cost of such speeds.

Nothing has been mentioned as to the cost of a horsepower in coal consumed at the various speeds, and, indeed, such a feature is without the scope of the present discussion. It may be noted in conclusion, however, that the forcing of the fires and engines incident to the maintenance of high speed is very detrimental to efficiency, and that a unit of power costs much more at 23 knots than it does at 15 or 20 (when the maximum speed is 23 knots). Thus the cost of coal (for the higher speeds) will vary with the speed at a still higher index than that shown for power.

Dravo Contracting Company Launches the Towboat Elsey Practically Complete

THE sternwheel towboat *Warren Elsey*, which is being built for the Vesta Coal Company, Pittsburgh, Pa., to be used in towing coal for the Jones and Laughlin Steel Company in the local rivers, was launched at the Engineering Works Department yards of the Dravo Contracting Company, Pittsburgh, Pa., on March 29.

In Ohio River side-launching experience the launching was unique, since the towboat was practically complete when she took the water. All equipment, including engines, boilers, piping, stern wheel, all auxiliaries and the upper cabin had been installed while the boat was still on the ways. The hull, boiler deck and pilot house are all steel; the crew quarters on the upper deck, however, are made of wood.

On account of the height and weight of the superstructure and machinery above deck, careful observations were made on the behavior of the boat during launching, including the determination of the maximum list, the list of the boat on recovery, the maximum depth of water taken, the angularity of the longitudinal axis of the boat to the ways when taking the water, the speed of the boat when leaving the ways, and the sagging of the boat after flotation. The accompanying cross-section illustration shows certain details during the launching period.

Launching Apparatus

Four pairs of equally spaced launching sleds were used. These were placed under the boat as built, level longitudinally and athwartship. The launching ways, which have a slope of 1¾ inches in 12 inches, are supported permanently on concrete piers, except for the outer ends, which are on piling.

Data Showing Behavior of the Boat When Launched

The height of the boat above water when leaving the launching ways was 3 feet 6 inches; the speed of the boat, 16 feet per second; the time of launching from the minute the lines were cut until the vessel took the water, 11 seconds; the maximum list of the boat, 9 degrees. The latter information was determined by the use of a glass U-tube with vertical legs spaced 3 feet apart, half filled with thin paint, and located at a fixed position on the upper deck. A pendulum indicator consisting of a 10-pound mass mounted on a stiff bar with an arm radius of 24 inches was also used. This was entirely unsatisfactory. However, better results might have been obtained had the radius arm been much shorter.

On the recovery the boat listed 5 degrees in the other direction. The boat dipped 18 inches lower on the stern when taking the water than the draft afterwards maintained at this point. The latter observation was made by two observers located on the shore with levels. The

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readings were taken on the stern flag staff, which was graduated. It was observed that the boat left the ways squarely. The two observers, sighting past range poles located at the water's edge, estimated only a 6-inch variation for the length of the boat.

The stern launching sled, which carried a weight of 111 tons, had a pressure of 4 1/10 tons per square foot on the ways. After flotation, the boat showed practically no sagging or hogging. The readings taken at quarter points showed a deflection of only one-sixteenth inch.

SPECIFICATIONS

The weight of the boat when launched was 367 tons, figuring displacement; the draft at the stern was 4 feet 3⅜ inches, and at the bow 2 feet 8¾ inches.

The main dimensions of the boat are as follows:

Overall length	162 feet 0 inches
Hull length	137 feet 5 inches
Beam	27 feet 0 inches
Depth	6 feet 6 inches
Chamber and dead rise, each	6 inches

The boat is fitted with two engines of the tandem compound type, 14 inches diameter of high-pressure cylinder, 30 inches diameter of low-pressure cylinder, and 6-foot stroke. The stern wheel is 20 feet in diameter and 18 feet 6 inches long. Steam is supplied by three boilers, each 40 inches in diameter by 28 feet long, at a pressure of 200 pounds per square inch.

American Sea-Going Merchant Shipping on January 1, 1919

THE sea-going American merchant ships of 1,000 gross tons or over on January 1, 1919, comprised 1,663 vessels of 5,656,856 gross tons, of which 1,344 of 5,138,664 gross tons were steamers (including 60 vessels of 125,421 gross tons propelled by gas engines), and 319 of 518,192 gross tons were sailing vessels. It should be borne in mind that in addition to these ships documented as merchant vessels the War Department and Navy Department are operating as transports and for other war purposes former merchant ships, not at present documented as such, numbering 55 of 396,829 gross tons.

The growth of this fleet during the calendar year 1918 is shown by the following statement of the total tonnage of such ships at the beginning of each month of 1918 and January 1, 1919:

Month.	Steam.		Sail.		Total.	
	Number.	Gross.	Number.	Gross.	Number.	Gross.
1918.						
January	817	3,147,349	324	534,351	1,141	3,681,700
February	829	3,226,031	324	533,268	1,153	3,759,299
March	834	3,258,809	312	516,248	1,146	3,775,057
April	866	3,391,826	312	514,604	1,178	3,906,430
May	880	3,456,834	316	520,340	1,196	3,977,174
June	927	3,364,905	319	524,921	1,246	3,889,826
July	965	3,788,676	315	518,216	1,280	4,396,892
August	1,017	4,005,296	318	522,327	1,335	4,527,623
September	1,061	4,133,317	318	521,659	1,379	4,654,976
October	1,131	4,360,606	315	513,200	1,446	4,873,806
November	1,201	4,614,021	319	519,396	1,520	5,133,417
December	1,264	4,827,263	316	514,372	1,580	5,341,635
January, 1919	1,344	5,138,664	319	518,192	1,663	5,656,856

During the nine months ended March 31, 1919, the output of American shipyards was three times the figures of the corresponding period a year ago. The output of wooden steamers increased from 22,171 gross tons during the nine months ended March 31, 1918, to 674,156 gross tons during the nine months just ended.

The total number of vessels built in American yards during the nine months just ended was 1,469, and the total gross tonnage 2,564,874. In addition to this, there were built for foreigners during the nine months ended March 31, 1919, 49 wooden vessels of 101,708 gross tons.

During the corresponding period a year ago, 1,065 vessels of 823,490 gross tons were built in American shipyards. In addition to the above, there were built for foreigners during this period 9 wooden vessels of 9,489 gross tons and 13 steel vessels of 39,042 gross tons, making a total of 22 vessels of 48,531 gross tons for foreign owners.

The 1,344 sea-going steamers of 5,138,664 gross tons on January 1, 1919, are classed by gross tonnage as follows:

SIZE (GROSS TONS)	Steel.		Wood.		Total.	
	Number.	Gross.	Number.	Gross.	Number.	Gross.
1,000-1,999	119	195,188	75	112,956	194	308,144
2,000-2,999	372	897,496	108	275,447	480	1,172,943
3,000 3,999	134	459,943	25	76,405	159	536,348
4,000-4,999	124	569,113	.....	.....	124	569,113
5,000-5,999	165	911,154	.....	.....	165	911,154
6,000-6,999	126	805,877	.....	.....	126	805,877
7,000-7,999	48	361,071	.....	.....	48	361,071
8,000 8,999	22	183,398	.....	.....	22	183,398
9,000-9,999	3	28,392	.....	.....	3	28,392
10,000 & over	23	262,224	.....	.....	23	262,224
Total	1,136	4,673,856	208	464,808	1,344	5,138,664

The fleet of 1,344 sea-going steamers of 5,138,664 gross tons on January 1, 1919, was established as follows:

ITEM.	Steel.		Wood.		Total.	
	Number.	Gross.	Number.	Gross.	Number.	Gross.
Amer. steamers on June 30, '14	384	1,349,631	19	26,121	403	1,375,752
Foreign-built steamers admitted to Am. registry under ship registry act of Aug. 18, 1914, and lesser acts	143	623,963	.....	.....	143	623,963
Seized German vessels	44	230,676	.....	.....	44	230,676
Built and documented year ended—						
June 30, 1915	12	62,222	.....	.....	12	62,222
June 30, 1916	35	172,356	2	3,063	37	175,419
June 30, 1917	61	317,236	21	30,991	82	348,227
June 30, 1918	194	861,654	45	88,704	239	950,358
Six mos. ended Dec. 31, 1918	263	1,056,118	121	315,929	384	1,372,047
Total built since June 30, 1913, and remaining on list	565	2,469,586	189	438,687	754	2,908,273
Grand Total	1,136	4,673,856	208	464,808	1,344	5,138,664

The foreign-built steamers admitted to registry and now under the American flag were all steel steamers (there being relatively few wooden sea-going foreign steamers) and were transferred to the American from the following foreign flags:

TRANSFERRED FROM—	Steel.		TRANSFERRED FROM	Steel.	
	Number.	Gross.		Number.	Gross.
British	63	264,739	Norwegian	2	8,188
German	25	130,350	French	2	6,596
Japanese	12	67,974	Chilean	1	4,725
Austrian	13	53,030	All other	9	29,807
Dutch	6	26,577			
Cuban	7	21,173	Total	143	623,963
Danish	3	10,805			

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Fig. 1.—Portion of the Pacific Coast Shipbuilding Company's Yard During Process of Construction, Showing the Concrete Bases of the Ways

Steel Shipyard on Suisun Bay, California

Pacific Coast Shipbuilding Plant Provides Eight Shipways on Concrete Foundations—Water Frontage of 2,800 Feet—Excellent Shop Facilities

THE Pacific Coast Shipbuilding plant, which is situated on the shores of Suisun Bay, a branch of San Francisco Bay, is about thirty-five miles on an air line east of San Francisco. The plant, which has the distinction of having been called "the shipyard twelve miles inland," is located along the waters of the bays—freshened by the Sacramento and the San Joaquin rivers, whose confluence lies not far from the yard—a circumstance which obviates barnacles and teredos and assures the preservation of submerged timbers.

Personnel of the Company

The company was organized in 1917 by men who have long been identified with shipbuilding and financial developments along the coast. R. N. Burgess, president of the Western Mortgage & Guaranty Company of San Francisco, assumed the presidency of the shipbuilding company. John T. Scott, builder of the old battleship *Oregon* and for many years identified with the Union Iron Works in San Francisco and later with the Moore & Scott Shipbuilding Company, serves as one of the vice-presidents of the company. G. S. Radford, a graduate of the Massachusetts Institute of Technology and of Annapolis, and for some time superintendent of the Norfolk Navy Yard and other naval posts, also serves as vice-president and consulting engineer. Mr. Radford has made a study of industrial organization in civilian life when connected with large enterprises, and has also served as contract manager for the Emergency Fleet Corporation. Colonel D. C. Seagrave, who serves as vice-president and general manager of the plant, has brought to the enterprise experience as a mining engineer, after his graduation from the University of Nevada, and executive ability gained from his work in the Field Artillery Corps after graduating from West Point, re-entering the Army during the present war to serve as executive assistant to General Williams, chief of ordnance. G. L. Downing serves as secretary and treasurer of the company. In addition to these officers, the board of directors includes Henry T. Scott, a pioneer steel shipbuilder of the San Francisco region in the eighties when connected with the Union Iron Works, who also has wide financial and industrial interests.

Yard Well Located

The site of the shipyard, which is one of the largest in the country, embracing 233 acres, is located in a rapidly developing industrial region near Bay Point, Contra Costa county, under the shadow of Mount Diablo. The plant has a water frontage of 2,800 feet, with ample space for the launching of the largest vessels. Three main railroads touch the property and two electric power lines are available, as well as three oil lines which tap the large oil fields of California.

On this advantageous location the plant was constructed in record time. Less than four months after ground had been broken for the work at the yard, the first keel was laid in the presence of Charles Piez, then vice-president of the Emergency Fleet Corporation. Six months to the day after the breaking of the ground four keels were down. Within a year of the beginning of operations the working force of the yard numbered 3,500 and was still growing.

As laid out, the yard is planned for the economical handling of material, with the demands for the future expansion of the yard always kept in view.

Eight Shipways on Concrete Bases

Eight shipways were provided for in the design of the yard. Four ways are in use, upon which are being constructed the ten 9,400-ton deadweight cargo steamers as

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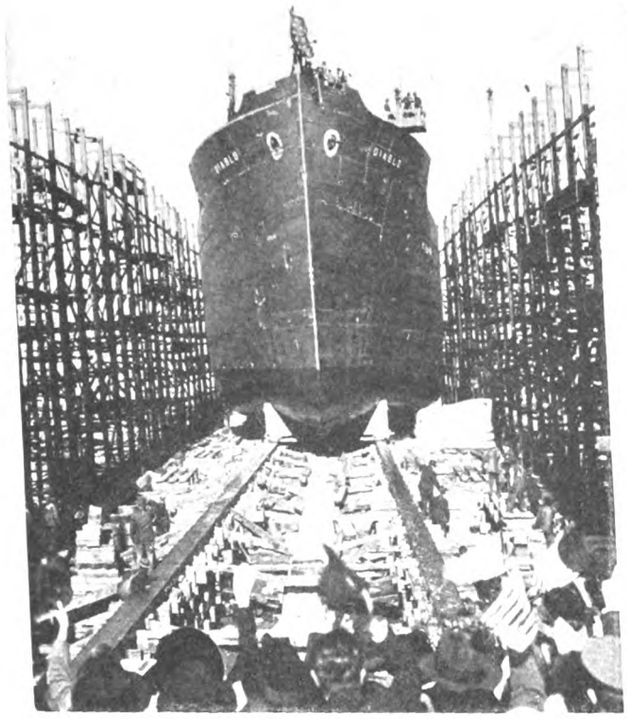

Fig. 2.—Launching of the *Diablo*

called for in the first contract received from the Shipping Board.

The foundations of the ways are of concrete. When the plant was being built there were only two other shipbuilding plants in the world in which the ways were constructed on concrete bases. This type of structure provides a capacity for building the heaviest types of ships, and will last indefinitely without repairs.

SHOPS AND STOREHOUSES

The most modern buildings have been constructed and the most efficient appliances installed for the handling of the materials at all stages. The plate shop, 80 by 400 feet, which is the largest building in the yard, was erected in eighteen working days. Special attention has been given to the uniform lighting both by day and by night of the mold loft, which is situated above the shop. A special building has been provided for the storage of templets.

The blacksmith shop, the machine shop—a 200-foot building—the saw mill and joiner shop, and the storehouse are all large and well fitted. The power house has been located close to the water line to facilitate the use of a short air line.

FITTING-OUT WHARF

The fitting-out wharf, which is now 500 feet long, is so constructed that its length can easily be doubled as the yard expands. This is also fitted out with the most modern appliances, and is connected with standard gage railroad tracks. Over two miles of trackage have been laid in the yards, all of which connects with the main lines of the railroads.

The yard is equipped with a special fire protection system, which has been approved by the Board of Fire Underwriters and the Emergency Fleet Corporation.

HOUSING PROVIDED FOR THE EMPLOYEES

The same care has been given to the welfare of the employees by planning of dwellings along the most sanitary and hygienic lines. With the assistance of the Shipping Board, a special town is being built for the employees named Clyde. This small city, which is situated three miles from the plant, will be directly connected to it by a special electric transportation railway. Much attention has been centered upon the completeness of the plans of the town, which furnishes comfortable, modern dwellings, making the most of California's residential advantages. Such minor factors as color scheme and variety of architectural design have been carefully planned by experienced artists. The housing and welfare department of the company operates a restaurant at the yard.

WORK PROGRESSING AT THE YARDS

The first ship which took the water at the plant was named *Diablo,* after the isolated mountain peak which overlooks the plant. Since the elimination of labor disturbances on the Pacific Coast, work is progressing at a normal rate at the plant and the yard is proving the advantages of the San Francisco district as a shipbuilding center.

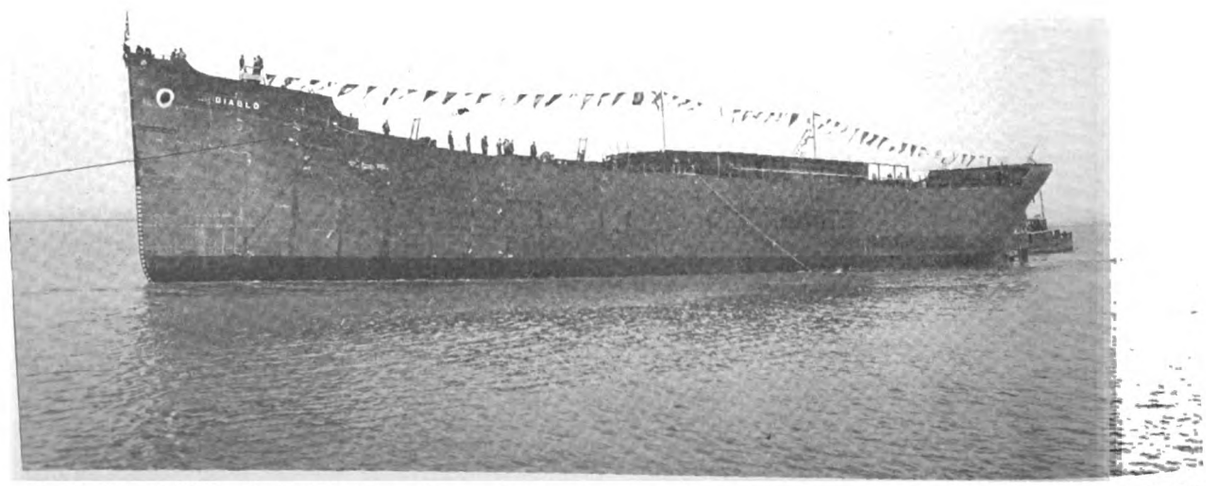

Fig. 3.—The 9,400-Deadweight-Ton Cargo Carrier *Diablo* After Launching. This Was the First Vessel Built by the Pacific Coast Shipbuilding Company

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Fig. 4.—Part of the Yard of the Pacific Coast Shipbuilding Company, Showing a Portion of the Ways and Plate Racks

The Tugboat Artisan—a Product of the Yard of M. M. Davis & Son, Inc.

THE tugboat *Artisan*, built by M. M. Davis & Son, Inc., at Solomons, Md., is 133 feet long overall, 125 feet between perpendiculars, 29 feet beam and 15 feet depth. Keels and keelsons, frames, stem and center keelson, are all of oak. The sheathing is of yellow pine.

Propulsion is by a triple-expansion engine built by the Bay State Iron Works Company, Erie, Pa. The engine is rated at about 1,100 horsepower, with cylinders 18 inches, 28 inches and 45 inches diameter by 30 inches stroke. The condenser is built in as a part of the engine and has 1,721 square feet of cooling surface.

There are two boilers of the Scotch type, each having 1,500 square feet of heating surface. The boilers are designed for a working pressure of 180 pounds per square inch.

The propeller shaft is 9⅛ inches in diameter at the thrust and 10¼ inches in diameter in the tail shaft. The propeller is 11 feet 6 inches in diameter and is designed for something over 100 revolutions a minute to drive the tug at 12 knots.

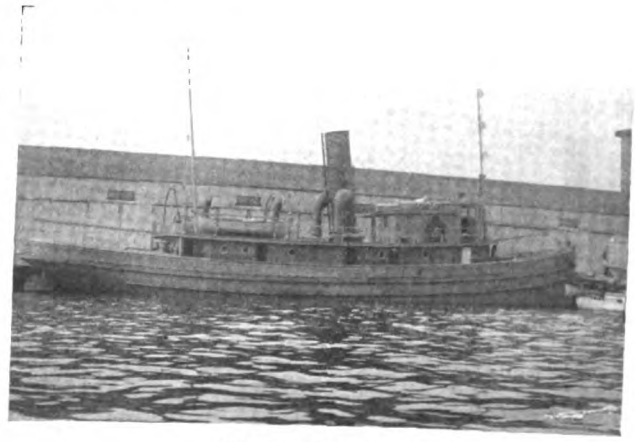
The usual auxiliary equipment consists of a circulating pump, donkey pump, feed and air pump, feed water heater, wrecking pump, electric generator, and all the other usual accessories.

Before the United States entered the war, the Davis shipyard was accustomed to turning out a few boats each year for the fishing trade and for the tugboat trade. At the time we entered the war they had orders for eight barges of about 1,600 tons capacity each and the hulls for two tugboats. One of these was the tugboat *Progress*, which the Davises were building for the Bethlehem Steel Company.

It is interesting to note in passing that the Bethlehem Steel Company, although one of the largest steel manufacturers of the country, has learned that the wooden tugboat is more durable, heavier and costs 20 percent less to build than the steel tugboat.

Combination With New York Engineers

Moses, Pope & Trainer, a New York engineering concern, decided late in 1917 that they wished to enter the shipbuilding field, and particularly the wooden shipbuilding field. They were not shipbuilders, but had specialized for many years in the design and installation of power plants and machinery. The first necessity, therefore, was to find the best wooden shipbuilder available, and the result was the combination of this firm with M. M. Davis & Son. The new combination, therefore, is responsible for the *Artisan* and for the seven other similar tugs now being completed for the United States Emergency Fleet Corporation, as well as for fourteen other vessels for the Quartermaster's Department. By this combination the Davis shipyard became builders of complete vessels, instead of builders of hulls only. The results, it is believed, speak for themselves.



Wooden Tug *Artisan*

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Operation of a Large Diesel Engine

IT will probably be some years before the design of Diesel engine rooms for motorships is sufficiently standardized so that all ships may be operated in the same way. Steamships have been so highly standardized that the average licensed steam engineer can go aboard any steamship and immediately take active charge of the duties for which he is licensed. However, the design of Diesel engine rooms is now approaching standardization.

The highest development of Diesel motorships appears to include full Diesel engines for auxiliary power and electric drive for all auxiliaries. The problem of heating the ship, heat for the evaporator and drive for the emergency compressor and emergency electricity for the wireless has not yet thoroughly been worked out.

A typical installation of the modern type consists of twin main engines operated from a working platform on the lowest level. At or near the level of this platform are two auxiliary engines driving generators, an electrically-driven auxiliary air compressor, two bilge and sanitary pumps, two fire and general service pumps and two circulating pumps for the main engine, all electrically driven. Besides these, there are lubricating oil pumps, fuel oil pumps, an ice machine and a turning motor for the main engine. On the upper deck on a level with the upper gallery will be the donkey boiler, the emergency steam-driven air compressor, the evaporator and connections for heating the ship.

In such a plant it is customary for one licensed engineer to be on watch on the working platform. On the upper platform is a junior who looks after the donkey boiler, evaporator, etc., also the valve gear and heads of the main engines. Besides these two engineers, there is an oiler for the main bearings and pins and auxiliaries. Besides this crew for running the engine there are usually three day men, who may be various modifications of the usual machinist, store-room keeper and wiper, carried on large ships.

The reason for having a "top side man" on a Diesel engine is that heads of a large Diesel engine require a great deal of attention. The "top side man" watches the temperature of the heads, the water discharge from the heads, the condition of the valves, noting particularly if any exhaust or fuel injection valves are sticking. He is also to make sure that each cylinder is getting its fuel, that the fuel pipes are not air-bound, and that the cylinders are all running alike. The latter fact is ordinarily determined by the temperature of the exhaust, since each exhaust pipe of the large engine is equipped with an ordinary plug thermometer or dial pyrometer. In extreme cases an indicator card is taken from the defective cylinder.

When making a Diesel engine ready to stand by, the first step is to start the auxiliaries. This includes the independent electrically driven circulating pump. Two are usually supplied, but one suffices, as a rule, for both engines, the other being in reserve. The lubricating oil pumps must be started and the day tank must be filled with fuel oil by means of one of the fuel oil pumps. The senior engineer then satisfies himself either by actual inspection or by communication with a trusted "top side man":

First, that the engine heads and jackets are filled with water properly circulating.

Second, that the engine is thoroughly lubricated at all points.

Third, that none of the valves is dirty or sticking.

Fourth, that the fuel oil pipes are full from the pump to the injection valve. This may be ascertained by the test cock near the injection valve. These pipes may be filled, if necessary, by using the hand handles on the injection fuel pumps.

Fifth, he assures himself that there is an ample supply of starting air at the proper pressure and of the injection air, also at the proper pressure.

Sixth, he makes sure, as in the case of a steam engine, that the engine is all clear, turning gear disconnected, all tools and tackle removed and that the engine is free to turn over.

Seventh, he assures himself that the auxiliary compressor is either running or ready to run.

Eighth, he communicates to the bridge that he desires to warm the engines up. A Diesel engine requires no "warming up" in the steam engine sense of the word; however, a careful man likes to be sure that his engine will turn over, reverse freely, and that all valves, etc., are in proper working order. A very few turns will satisfy him of all this, and it is not necessary to run the Diesel more than a few revolutions to establish these facts.

The handling gear of the Diesel engine has been pretty well standardized. It consists usually of a wheel for reversing the engine and two throttles for handling. Each throttle is for three cylinders of the usual six-cylinder engine. By pulling the two levers out, they act as air throttles admitting air to the Diesel engine and starting it exactly as a steam engine is started. The levers are then shoved in clear across the centerline, whereupon they close the air off and act as oil throttles, admitting oil to the engines. The engines may then be maneuvered by manipulating the oil throttles in much the same manner as an ordinary steam throttle valve.

It is customary to hold one lever back, thus keeping three of the cylinders turning over with air, while the other three cylinders take oil. As soon as the engine takes the oil, the second lever may be thrown over and the engine is under full operation. It is customary to throw the oil valves wide open when starting a Diesel engine, in order that it may make a quick "getaway" and run no chance of a "stall," which may happen if an operator is too easy about starting. As soon as the engine is under way the oil throttles may be brought back to any desired position. This position depends, first, upon the speed of the engine desired; second, upon the smoke in the exhaust, and, third, upon the safe load for the engine.

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The speed of the engine depends, of course, upon the signal received from the bridge. The smoke in the exhaust indicates poor combustion either from feeding too much oil or not enough injection air. The smoky exhaust is detected by the "top side man," who regularly opens the test cocks on the exhaust pipes for inspection. The safe load of a Diesel engine is about two-thirds of the maximum load that it is capable of carrying.

If an engineer persists in running his engine at more than 80 or 85 pounds mean effective pressure, he is inviting many troubles. These include cracked cylinders and heads, heated bearings, sticking valves and numerous minor troubles. This is the point where American Diesel manufacturers and engineers have fallen down in the past. It is the American temperament to run a machine to destruction. Ninety-nine percent of success with a Diesel engine is to hold the mean effective pressure under 85 pounds. Outside of this there is no secret to the operation of a Diesel engine except good mechanical care. The operation of the Diesel engine is a very simple matter and it has been explained in many books and periodicals. The writer, who has operated both Diesel and semi-Diesel engines, wishes to go on record as saying that the average Diesel or semi-Diesel made to-day by responsible manufacturers will give satisfaction if its rating is not extended and if it is given the same care extended to a licensed steam engine and boiler.

The writer has inspected, or had knowledge of, possibly several hundred marine Diesel and semi-Diesel engines in actual operation. While there have been accidents which could not have been foreseen, he has never known but one case of general deviltry which could not be traced directly to one of these two causes—that is to say, either the engine was overloaded or was in the hands of incompetent men.

The following statement appeared in a San Francisco newspaper at the date this article was written:

"The auxiliary ship ——— arrived in port after an 86-day sail from Sidney. The boat was equipped with ——— semi-Diesel engines, but the bo's'n, who had an engineer's (?) certificate, could not start the engines, so the good ship *sailed* all the way home."

MARINE ENGINEER.

A Plea for the Apprentice

The training and technical education of the average engine fitter and boiler maker sadly require attention from employers. A boy eager to become an engineer enters a marine engineering shop—probably he is bound for five years' apprenticeship, which means that his employers are to teach him the trade of fitting, while he must serve them during the named period. His first interview is with the timekeeper, who initiates him into the hours of work and the penalties of any lapse of discipline. He is passed on to the foreman of generally the nearest shop, who promptly looks around for a machine man requiring a mate. The writer well remembers being taken over to a machine for turning the taper in the bossing of a propeller and the foreman's instructions to keep a note book and sketch.

So far, so good; but is this good enough? What impression does the young engineer get of his future work? Generally it is a poor one and he feels anything but happy. *En passant* I will be forever grateful to my first machine man, who gave me the soundest advice I have ever received. He told me never to funk a job. If you can't see even the first step—well, take your coat off or get out a file. Do something and the rest will come, and I have found this true.

My article is not a complaint, but a plea for a more careful consideration of the training of the apprentice in marine and boiler shops. If the boy, who by now probably is bored to death with the machine and gets into trouble because he will wander around other machines, asks for a move, he may get it or he may have to desert and risk a row; but, as a rule, he has to move on his own initiative. He then gains some experience as a fitters' mate, either in the form of an older apprentice or a journeyman. This is good if his mate is good, but he is not always good.

After two years of this casual training a boy in the lathe shop wants a move, and a chance opens for a boy in the fitting shops. A lucky one gets it and leaves several unlucky comrades behind, and so the tale of chance goes on. Granted it is that a boy with a good purpose can get around and learn, but it is generally no fault of the employer if he does so.

The writer knows within his personal experience of an apprentice who desired to learn lathe work, and, failing to be moved, he disappeared out of the fitting shop and was found in the lathe shop, from which he refused to move; so the foreman of the fitting shop went to the foreman of the lathe shop and damned the boy's character. Such was the result of ambition.

Generally three or more apprentices are required in the boiler shop to fit mountings and repair the machinery of the shop, but there is no roster kept enabling all the apprentices to learn this necessary work, and the writer had to follow the step of the boy who wanted to go to the lathe shop before he could gain this experience, and this method, although serving its purpose, is not good for the discipline of the shop or the apprentices.

The construction of boilers is a very essential knowledge to the engineer, yet how few of the apprentices are given the opportunity of actually working on boilers, fitting the mountings or actually running the boiler on the test. The marking-off table requires only one apprentice to act as mate; but is there any need that once an apprentice has learned the job he should be kept there because the journeyman is too lazy to teach another boy? For an apprentice to become efficient at any job, such as fitting boiler mountings, marking-off, turning or erecting, generally signs his death warrant so far as having opportunities of learning other sides of engineering. Apprentices come and go, and it seems as if every one is happy so long as there are plenty of mates to work with the journeymen.

Comparisons are odious, but why is it that apprentices in locomotive shops are guided through the different grades and not so apprentices in marine and boiler shops? Again, let us consider the technical training of our young engineers. Is it not quite recently that an apprentice is allowed to lie in on the morning after night classes? But not yet is it a universal practice to encourage practically the attaining of technical distinction. To allow a few hours' extra in bed after night classes and not to insist on results of the classes is only, in a majority of cases, breeding laziness. The writer has had some experience of night class lectures, and the classes are generally made up of two kinds of boys—those willing to learn, and the others who attend in order to have this class card initialed and so earn a few hours' sleep next day. Beyond this privilege mentioned, there is nothing to encourage night study except ambition, which, in most cases, is dormant until a boy reaches, say, eighteen years or even more.

There are too many poor and medium fitters and an insufficient number of well-trained engineers; and the blame lies mostly with the head of boiler making and

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engineering establishments. It is as easy for a good working scheme to be thought out and put into practice as to "carry on" in the present slipshod fashion. It will benefit the employer in the long run, for, instead of having a crowd of so-called fitters hanging around his door waiting to be taken on, he can have a group of regularly employed engineers and boiler makers inside the shop.

It is my experience, and I ask the employer to believe me as a late apprentice, that these casual fitters run up the cost of a job about thirty percent. Is there any doubt that a good, well-trained fitter or boiler maker is worth two semi-trained men? I do not think so. Again, does not *esprit de corps* play another part in a good workman's life? Is it not worth money to the employer—yet, who can expect such a spirit from the man who knows he downs tools when the job is done?

Combine these two, a well-trained fitter or boiler maker and a man with a keen sense of *esprit de corps,* and surely he can compare with at least two casual fitters.

In France, during the last four years, millions of men have faced death for one word and what it means—"honor." Cannot this word be introduced into the engineering shop, or is it for the battlefield only? A boy wandering and drifting through a boiler or fitting shop never hears or sees the word, and, consequently, what are the works to him? He knows that as soon as his apprenticeship is finished his firm will perhaps offer him a pound a week, but they do not mind whether he stays or goes. They themselves place a value on their own training of an apprentice, and it amounts to nothing.

If I am asking too much for a drastic change in the system of apprenticeship, there are several smaller alterations that would mean big improvements. Why cannot there be practical tests each year with suitable encouragement to the apprentice and such places as the drawing office and marking-off table or boiler fitting shop open to the best apprentices? The boy who can use a lathe well is just the one to teach how a boiler is made and how a safety valve is made and mounted, and the boy will then be an all-round fitter.

The drawing office should be the reward of four years' hard studying—not a mere chance, as it generally is. When the writer served his apprenticeship he never saw one boiler maker apprenticeship in the drawing office, and yet his firm made marine boilers. In several big firms the sons of well-to-do men can, for a certain sum of money, ensure a good training in the different shops, but it is very rare that a poorer man's sons can do so. They must be content to stay in one shop. It does not make any difference how clever they may be.

The want of all-round trained artisans has been revealed in this war. There have been plenty of men who could do special fitting jobs, such work as they had been used to for years; but if a particular lathe man became ill the lathe was out of use until another lathe man was sent up. Yet these so-called fitters had served an apprenticeship in shops where lathes were used.

So much for the practical side of an apprentice's training; but what about the commercial side? Does he ever see inside a cost office or the estimating department except to take an occasional message? How many apprentices can tell you what the working expense of the firm is or how the file that he uses is bought and paid for? I often wonder if he ever realizes that a file or chisel costs money. It is doubtful, and yet if he knew that the more jobs a file is used on the cheaper will be the different jobs, and, consequently, the more ultimate business for the firm, surely his knowledge will be a gain to the firm.

This article has dealt mostly with the result to the firm, but it is the same with the apprentice—commercial knowledge is essential to-day. I notice constantly articles in technical papers on how to make an engineering firm pay. Surely this subject should be a part of the apprentice's education. It is quite as important for a man to know how an order is taken, sized up and estimated as how to carry it out. The other day an American engineer was brought over to England to manage one of our railways, and a certain English lord bemoaned the fact that this should be necessary and he wondered why. Let him go to any engineering firm, select any of the apprentices who have worked their way into the drawing office and ask them to tell him how the counting house or cost office is run. He will be surprised at their ignorance, yet these are important parts of a modern engineering firm, and the general manager has to know before he can attain this position.

Not many apprentices realize the weakness of their training until they become journeymen and they have ambitions towards higher jobs. Then they have to look around for books to teach them what they should have learned years ago, and, as a consequence, their time is taken up in acquiring general knowledge instead of specializing.

Now is the time for changes. Let this subject be on the list of consideration. Ten minutes' thought will be sufficient to reveal its necessity, and very little time is required to put into action a working scheme. Some firms, very few, have done so more or less; yet even they have not done all they can. Surely a big firm can afford an apprentice master whose time and energy are to be spent in controlling the teaching and training of the apprentice. Such a man should be one capable of lecturing at the night classes so that he is in touch with the apprentices during the evening as well as the day. His work in the shops need not clash with the foreman, for he is simply there to see that each apprentice goes through the different departments and that any ability developed is used accordingly. The good can be separated from the bad much better by this master than any one foreman, and the apprentices themselves will realize the importance attached to their training.

The technical committees of different towns do their best to train the apprentice theoretically, but there is at present no means of keeping a direct connection between the committee and the firms employing the boys during the day. The possibilities of good to be done by employing a qualified apprentice master are enormous, and the money invested would yield a high interest in years to come, and I should like to read of other opinions on the matter.

M. T.

NEW BOOK

STEAM ENGINE TROUBLES. By H. Hamkens. Size, 5 inches by 7⅜ inches. Pages, 284. Illustrations, 276. New York, 1919. The Norman W. Henley Publishing Company. Price, $2.50.

For the practical operating engineer who has charge of stationary engines, it is of great advantage to have a comprehensive knowledge of engine troubles in general, so that costly and dangerous accidents can be avoided. In this book the troubles which the principal parts of steam engines are subject to are described, good design is contrasted with bad, the most suitable material for certain parts and the most approved construction of the same are pointed out, together with the advantages and disadvantages of many designs. No reference is made to the peculiar conditions encountered in handling marine engines.

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Questions and Answers for Marine Engineers

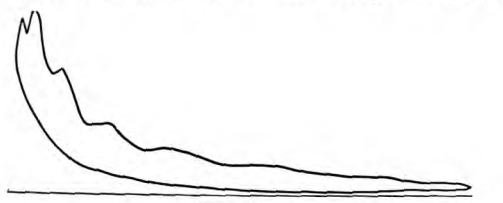
Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

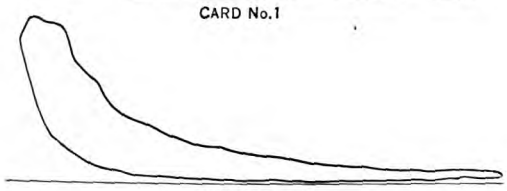
Indicated Horsepower of Diesel Engine

Q. (1003).—Please work out the indicated horsepower of an eight-cylinder, four-cycle Diesel engine, using the mean effective pressure as obtained from card No. 1, and also card No. 2. Diameter of cylinder, 13½ inches; stroke, 15 inches, and 380 revolutions per minute in both cases.

A. (1003).—From the tabulated calculations you will note that card No. 2 gives a higher value for the indicated horsepower than card No. 1. The wavy line of diagram



CARD No. 1



CARD No. 2

No. 1 was most likely caused by the indicator piston sticking. The table below gives the result reached:

Indicator Card	No. 1	No. 2
Net area of card, square inches	.379	.455
Length of card, inches	2.53	2.64
Spring, pounds per square inch	600	600
Mean effective pressure, pounds per square inch	89.9	103.5
Length of stroke, feet	1.25	1.25
Piston area, square inches	143.1	143.1
Revolutions per minute	380	380
Indicated horsepower, per cylinder	92.6	106.7
Total indicated horsepower	741.8	854.6

$$\text{Indicated horsepower of one cylinder} = \frac{\text{M. E. P.} \times 1.25 \times 143.1 \times \frac{380}{2}}{33{,}000}.$$

Propeller Efficiency of Motorship

Q. (1005).—Data on the apparent slip of propellers are generally quoted as follows: Slow cargo boats with full lines, 0 to 8 percent; passenger boats with fine lines, 8 to 15 percent. These figures have been based and have been experienced on ships equipped with slow-speed engines, being even on large ships always under 100 revolutions per minute; but these figures do not hold good on motorboats whose engines are running at a much higher speed. In my particular case I have to deal with a twin-screw cargo boat of 8¾ knots' speed, to be equipped with two 550 brake horsepower engines, which are turning 270 revolutions per minute. The question is: What will be (1) the slip at this speed, and (2) how much would it be if under the same conditions a reduction gear were installed and the propeller shaft then turned over at 90 revolutions per minute? I am interested to know this slip beforehand, in order to figure on the basis of these data the propeller efficiency of these two different cases.

A. (1005).—The slip of a propeller depends upon the type of vessel, the propeller and its location. Hence it is very hard to give any definite answer to your question, except to say that for most vessels an apparent slip of more than 25 percent shows a fall of efficiency. In a case, cited by Admiral Dyson, of a naval fuel barge, the least effective propeller had a slip of 50 percent, and the most effective about 26 percent, the pitch ratio in the latter case being about 0.57. For your direct drive at 270 revolutions per minute you must expect to use a propeller with low pitch ratio, which will be inefficient but more efficient than one of high pitch ratio. Some of the data for low-powered auxiliaries show that a high-speed motor has been used with a pitch ratio of about 0.8; this will mean a propeller of poor efficiency when loaded under power alone, but may have been chosen with the idea of using motor and sails together. Most of the large steel motorships built in Europe have an engine speed of 130 revolutions per minute or under. Although formerly propellers were designed with reference to the apparent slip, Taylor's method does not require that the slip be assumed, but the wake factor must be chosen instead. This factor depends on a number of conditions. From Luke's "Experiments on Wake" we learn that for outboard turning twin screws a decrease in diameter will decrease the wake.

The reduction gear installation will show a far higher overall efficiency than the direct drive. This may be demonstrated by using data from Admiral Taylor's experiments.

Taking the revolutions per minute equal to 240, assume wake factor = 0.15, and efficiency of reduction gear = 0.98. Then from Fig. 213 of "Speed and Power of Ships":

R. P. M.	240	80
V.	8.75	8.75
V_a	7.44	7.44
B. H. P.	550	550
P.	37.3	12.4
Propeller efficiency	52.5*	64.8
Efficiency of propeller and gear.	52.5	63.5

$$P = \text{R.P.M.} \sqrt{\frac{\text{B.H.P.}}{V_a^5}}$$

* The efficiency curve is extended.

Although these figures should be carried out more carefully for the actual case, it is believed that they represent fairly well the relative efficiency of the two installlations. (The pitch and diameter for both cases may be obtained by carrying the solution further.)

The following references are interesting: *City of Portland*, page 292, 1916, MARINE ENGINEERING; *Cethana Motorship*, September, 1918; *James Timpson Motorship*, March, 1919.

If the reduction gearing will stand up under the fluctuation in turning moments, I believe that it offers the best solution of an efficient propeller and engine.

Fastening Zinc Plates in Boilers

Q. (1004).—I would like to know as soon as possible what the conditions are in regard to the bolts that hold up the zinc plates in marine boilers. Is it necessary to paint these bolts to keep them from rusting or is there anything on the market that can keep them in a polished state for metallic connection to zinc plates?

A. (1004).—The zinc plate neutralizes the free acids in the water by combining with them, thereby preventing the iron from corroding. Since we thus have an electrochemical process, it is of the utmost importance to get a perfect electrical contact. If the zinc is held by pieces of flat bar, or by a basket, the important thing is to make certain that the connection between plate and boiler is through clear metal, i. e., oxide left by the blacksmith on bar iron in way of bolt is filed off. If desired, a cement wash may be put on the bolt which clamps the zinc plates to the hanger after assembling.

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Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

PROPOSED VESSELS TO BE BUILT BY THE EMERGENCY FLEET CORPORATION

Increased Capacity, Greater Speed, Efficient Loading Facilities in the New Designs

It has been learned from the office of the Emergency Fleet Corporation, in connection with the recent bid of the Submarine Boat Corporation to build vessels of 12,000 deadweight tons capacity at $149 per ton, that this bid was in no sense a formal one, in so far as the corporation submitted neither specifications nor drawings.

TWO TYPES OF LARGE CARGO VESSELS UNDER CONSIDERATION

Two new types of vessels, however, are now under consideration which may be substituted for vessels of smaller tonnage and slower speed, on which work is now suspended. Bids have already been asked on a 12,500-ton vessel with a sea speed of thirteen knots. Specifications of the two types are as follows:

	"A"	"B"
Length B. P., feet	470	470
Breadth, feet	63	63
Depth, feet	43	43
Deadweight, tons	12,500	14,200
Indicated horsepower	5,600	4,000
Speed (sea), knots	13	11½

The vessels will be of the shelter deck type with three decks. The machinery will be of a reliable and economical type consisting of a quadruple expansion engine and Scotch boilers, and arranged for burning oil fuel. The capacity of the oil bunkers is such as to give the vessels a radius of about 13,000 miles.

Particular attention has been paid to the economical handling of cargo, and to obtain this end two large hatches have been arranged at each hold. These will be served by double the usual capacity of winches and booms.

The accommodations for the officers and crew have been carefully studied and provide for the latest ideas as to comfort and safety. The vessels will also comply with the highest requirements of the American Bureau of Shipping and Steamboat Inspection Service.

Two types, "A" and "B," as given above, have been suggested, the principal difference being in the speed and consequent modification in deadweight capacity. On certain trade routes the higher speed of 13 knots may be desirable, and on others, depending somewhat on the length of voyage and other factors, the slower speed of 11½ knots may prove more economical.

The details of the proposition, as outlined by the Submarine Boat Corporation, are as follows:

"We are willing to undertake to build for the United States Shipping Board 12,000-ton, deadweight capacity, new American type, steel cargo ships at the Government-owned plant, Newark Bay Shipyard. . . . .

"The proposed ships will be 12,000 tons deadweight capacity steel cargo carriers, shelter-deck type, classed Lloyd's or American Bureau of Shipping 100-A1, of the transverse system of construction; length of ship between perpendiculars (Lloyd's) 473 feet, molded beam 62 feet, draft 28 feet 6 inches, single screw equipped with 5,000 indicated horsepower reciprocating steam engines, or 4,200 shaft-horsepower geared turbines, Scotch boilers, oil burning, with which power a loaded sea speed of 12 knots will be guaranteed.

"The ships would be built from the designs of our naval architect, Theodore E. Ferris, in association with our consulting naval architect, Frank E. Kirby."

NEW SOUTHERN YARD RECEIVES CONTRACTS FOR NINE CONCRETE STEAMERS

Newport Shipbuilding Corporation, Ltd., Begins Laying Down Work

The Newport Shipbuilding Corporation, Ltd., has built and equipped an extensive yard for the construction of reinforced concrete river steamers at Newbern, N. C. The officers of the company are as follows: F. E. Engstrum, president; F. O. Engstrum, vice-president; T. A. Uzzell, treasurer; R. H. Arnold, general manager, and F. R. Miles, superintendent.

This company has received a contract from the War Department of the United States Government for the construction of nine reinforced concrete river steamers designed for transporting men to various points on rivers and harbors. At present the company is engaged in laying down the work for these vessels. Whittelsey & Whittelsey, 17 Battery Place, New York, are the naval architects for the company.

Page Resigns from Shipping Board

Charles R. Page, the San Francisco member of the United States Shipping Board, has forwarded his resignation to the President.

SKINNER & EDDY RECEIVE REINSTATEMENT ON CONTRACTS AGGREGATING 250,000 TONS

Will Construct Twenty-five Vessels

Contracts for twenty-five steel vessels, to be constructed by the Skinner & Eddy Corporation, Seattle, Wash., for the Emergency Fleet Corporation, which were recently suspended, are to be reinstated according to information from Washington received on April 12. The agreement with the corporation, it was stated, involved certain reductions below the original price. About 250,000 tons are involved.

Orders have been received by the G. M. Standifer Construction Corporation, Portland, Ore., to fit the four Ballin hulls remaining on the ways with machinery. The Supple-Ballin Shipbuilding Company, Portland, Ore., had previously received orders to fit up four vessels of the same type with machinery.

Norwegian-American Line Lets Contract for Two Freighters

The Norwegian-American Line, 8 Bridge street, New York, has recently let contracts for two modern freighters of 9,500 tons deadweight to Napier & Miller, Glasgow, Scotland.

Pacific Steamship Company Will Build Coastal Vessels

A. F. Hines, vice-president and general manager of the Pacific Steamship Company, San Francisco, Cal., has announced that plans are being drawn for the building of two fast oil-burning steamers for coastwise trade. The new vessels, which will carry both passengers and freight, will be 500 feet long, with a speed of 21 knots. It is proposed that the vessels be built on the Pacific Coast, although the lowest bids will be accepted.

A new line known as the White Flyer will operate vessels in competition with the Pacific Steamship Company. The new company has been formed by Adolph Ottinger and Walter Scammell.

Dollar Steamship Company Will Build 10,000-Ton Vessels

Robert Dollar, president of the Dollar Steamship Company, in discussing the new freight service between New York and Vancouver which the company is planning to establish, has announced that special steel ships of 10,000 tons will be built for this service.

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DAUGHERTY TYPE WOODEN VESSELS SOLD AT $650,000 EACH

Nacirema Steamship Company Purchases Fifteen Vessels—Will Buy Fifteen More for Future Trade Development

The consummation of the sale by the Shipping Board of fifteen 4,000-ton wooden steamships to the Nacirema Steamship Company, New York, as reported in the press of April 23, at a price of $650,000 each, is an indication of the prices which may be expected in the sale of well-built wooden tonnage. The fifteen vessels purchased will be operated by the Brooks Steamship Company, New York, five operating out of New York, five out of New Orleans and five out of Havana. The Nacirema Steamship Company, it is reported, is planning to purchase fifteen more vessels at a later date.

Ten of the vessels were built by the National Shipbuilding Company, Orange, Tex., and five by the Supple-Ballin yards, Portland, Ore. The former are of the Daugherty type, and the others of the type built at the Ballin plant.

Underwriters report that not a dollar of loss has been incurred in the operation of thirty ships of these types by the Matson Navigation Company, San Francisco, Cal., which, they point out, indicates the efficiency of these types of wooden vessels for trans-ocean service.

The Shipping Board, coincident with the announcement of this sale, has solicited bids for twenty-five wooden vessels to be opened on May 5.

PRESENT NAVY PROGRAM

Four Hundred and Thirty-eight Vessels Yet to Be Delivered

According to Washington reports, ships of all classes now building for the United States Navy number 438, including 10 superdreadnoughts, 6 battle cruisers (suspension orders on which were recently issued, as noted in the NEWS SUPPLEMENT of March 14), 10 scout cruisers, 195 destroyers, 71 submarines, 53 Eagle boats, 20 mine sweepers and 71 auxiliaries. Under the latter are included 12 oil tankers, 3 fuel ships, 2 ammunition ships, 1 hospital ship, 19 seagoing tugs and 34 harbor tugs.

Several of the superdreadnoughts have already been laid down. The *Tennessee*, building at the New York navy yard, will be launched some time in May; the *California*, at Mare Island, Cal., and the *Maryland*, at Newport News, Va., are well toward completion; the *Colorado* and the *Washington* have been laid down at the New York Shipbuilding Corporation's plant at Camden, N. J. Two more superdreadnoughts are to be built at the New York navy yard, one at the Mare Island navy yard, and another at the Norfolk navy yard.

Shipping Board Asks Bids on 431 Wooden Hulls

Bids for the purchase of 431 wooden steamship hulls and 31 wooden barge hulls were asked by the Shipping Board on Friday, April 26, as a part of its programme for disposing of surplus bottoms constructed during the war emergency. The vessels, it is reported, may be converted into sailing vessels or barges equipped with internal combustion engines if desired. Ship fittings—engines, boilers, winches, cables, etc.—can be supplied by the Emergency Fleet Corporation to complete the ships if necessary. In most cases these materials are already in the yards. Bids will be received until May 26 accompanied by cheque for 10 percent of the amount of the bid.

The United States Shipbuilding Record for One Year Totals 3,225,000 Gross Tons

From April 1, 1918, to April 1, 1919, a total of 2,056 merchant vessels of 3,225,521 gross tons were built in the United States, and officially numbered by the Bureau of Navigation, Department of Commerce. Of these, steel seagoing vessels amounted to 2,178,939 gross tons.

SHIPPING BOARD REFUSES BIDS ON FOUR VESSELS

Offers for Reconstructed Lake Carriers Less Than Half Appraisal

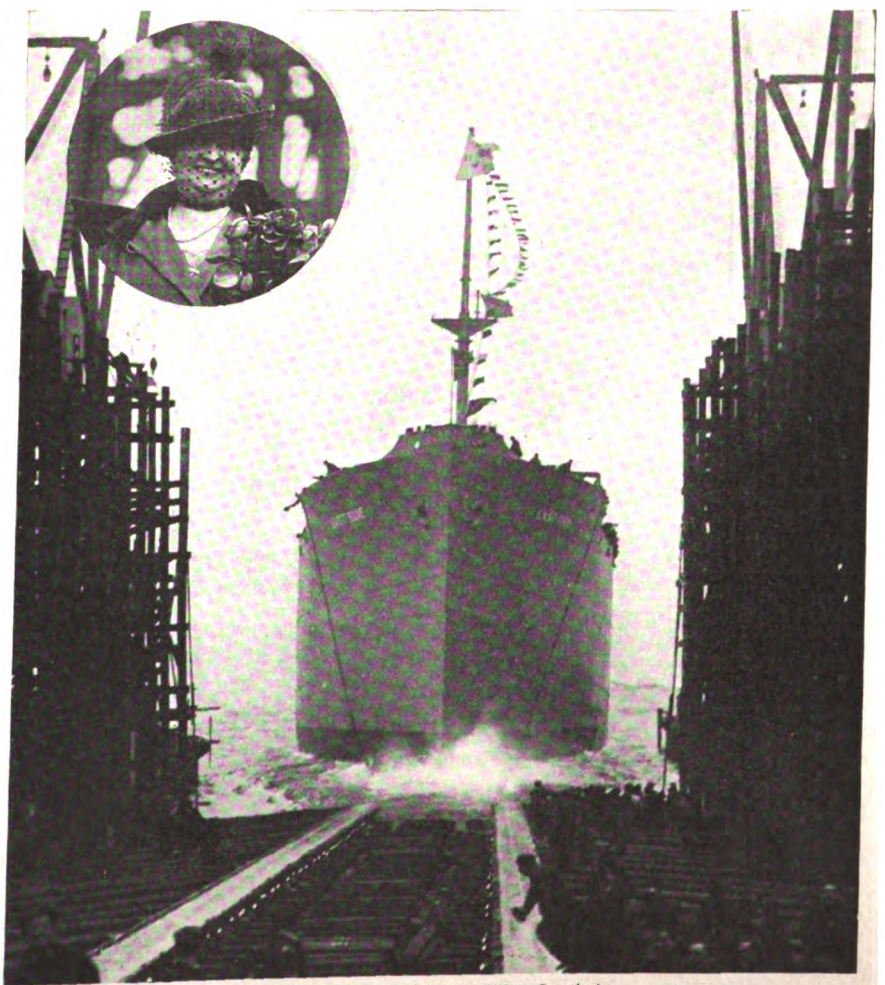
All bids received by the United States Shipping Board for four steel reconstructed lake steamers were refused on April 22, and the vessels were again advertised for sale, bids to be opened on May 5.

"The prices were about 40 percent of the appraised value of the vessels as determined by the Ocean Advisory Commission by a fair and impartial appraisement," is the statement issued by the Shipping Board.

Edward P. Farley & Company bid $142,000 each for the four vessels, the *Adrian Iselin*, 3,075 tons deadweight; the *Lucius W. Robinson*, 2,825 tons; the *F. P. Jones*, 2,850 tons, and the *A. D. Mac-Tire*, 2,925 tons.

N. A. Iselin & Company bid $158,000 for the *Iselin*, $126,000 for the *Robinson*, and $133,000 each for the *Jones* and the *Mac-Tire*.

The New England Fuel & Transportation Company bid $1$1,000 for the *Robinson*.



(Photo by International Film Service)

The *East Side* Launched by the Standard Shipbuilding Corporation, Shooter's Island, N. Y., on April 5

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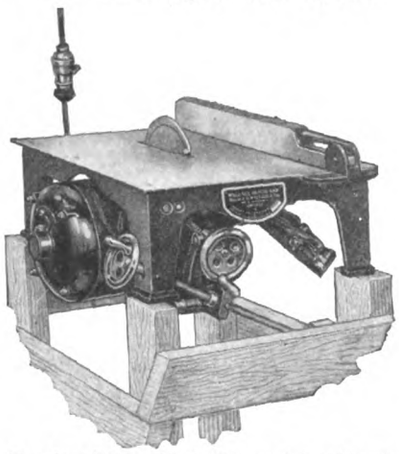
New Wallace Bench Machine

The Wallace bench saw, which is being put on the market by J. D. Wallace & Company, 1407 West Jackson Boulevard, Chicago, Ill., is a portable bench tool designed to be operated by ordinary electric light current. It has ample power to take a full 2-inch cut through the hardest wood, making it possible to use this machine for at least 80 percent of the work generally done by hand or on the big circular saw in the pattern shop. For angle cutting the saw itself is tilted, consequently the operator is always working on a table which is in a horizontal position. By a handwheel mounted on a perfectly cut screw, acting in a swiveled nut, the saw may be set at an exact angle. This mechanism swings the cradle in which the motor-driving mechanism and saw are mounted.



Portable Bench Tool Operated by Electric Current

The Wallace saw is provided with a shutter saw guard built into the machine to protect the operator's hands, and to prevent the catching of the end of the stock in the back of the saw or the catching of the waste stock in the teeth of the saw.

Smooth-On for Repair Work

Smooth-On, which is manufactured by the Smooth-On Manufacturing Company, Jersey City, N. J., may be put to many uses in and around the shop for quick repair work. The mixture, when brought to the consistency of putty, can be utilized to fasten metal to a brick or concrete wall, or to tighten loose handles on tools. Mechanics have found it of use in permanently fastening washers or lock nuts to bolts, imbedding sockets in cement and fixing lock nuts in similar material. Smooth-On Number 1 is the preparation used for such jobs.

Dreadnaught Rubber Safety Suit

A new safety suit called the Dreadnaught, which has recently been put on the market to replace the ordinary life preserver, is the product of the Safety-At-Sea Corporation, 1358 Broadway, New York city. The apparatus consists of a one-piece garment of rubberized material which, the company claims, is absolutely watertight unless cut or damaged. The elastic rubber collars and wristlets, which may be noted in the illustration, are adjustable to any size of neck or wrist. The soles are of pliable gravity leather. The buoyancy of the garment is furnished by a silky fiber jacket made of Kapok, which fits inside the rubberized coat. Either coat or jacket may be worn separately.

Dreadnaught Rubber Suit

The complete apparatus, which can be adjusted in less than a minute, is furnished in a special canvas carrying wrapper which measures approximately 18 inches by 12 inches by 7 inches and weighs only 14 pounds. The suit may be worn in case of shipwreck or as a protection to seamen engaged in work about the ship in rough weather.

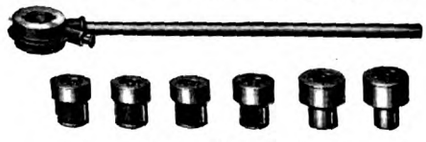
Shipping Board Converts One Hundred Ships Into Oil Burners

Report has been received that the Shipping Board is planning to convert 100 vessels, built on the Great Lakes and equipped to use coal as a fuel, into oil-burning vessels. Major Cushman, Assistant Director of Operations, has verified the report, but is unable to give details because the arrangements have been handled direct from Washington.

Within two weeks of the opening of navigation a fleet of ninety-eight ships will be brought down the St. Lawrence River from the Great Lakes. At least 300 ships will be completed here during the summer. Of this number 150 will be oil burners. The average tonnage of the ships is 3,500 tons. The fleet will also include fifty seagoing tugs, all of which have been built on the Great Lakes.

The Beaver Jr. Number 3

The accompanying illustration shows a pipe-threading tool known as the Beaver Jr. Number 3, which is supplied by the Borden Company, Warren, Ohio. It consists of one ratchet handle and individual die heads in sizes ranging from ⅛ to 1 inch. The tool can be used to advantage close to walls or rafters, in corners, against ceilings or in other difficult positions. Separate heads can be furnished to cut left-hand threads. The ratchet is controlled by a spring thumbbolt of large size with a good grip, so that it can be turned with greasy hands without trouble. The Number 3 Beaver Jr. is made in American Briggs Standard and Whitworth Pipe Standard.



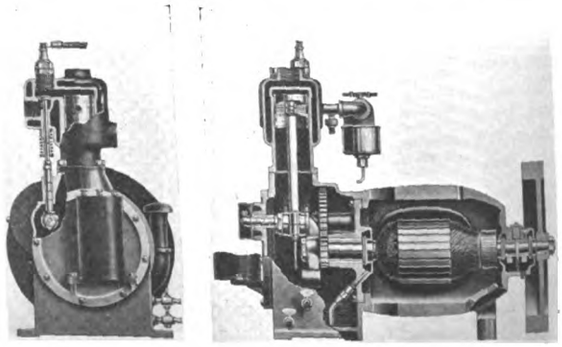
Beaver, Jr., Number 3

Compact Lighting Plant for Marine Installation

The Matthews Engineering Company, Sandusky, Ohio, has added a new unit, "Little Husky," to its line of full automatic lighting plants. This plant, which carries a 300-watt continuous rating on the generator, is made in the 32-volt type.

The generator frame and engine crank case are cast integral. The engine is a 4-cycle cooled type of 2-inch bore and 3-inch stroke. A 60-ampere hour Willard glass cell storage battery is used with the plant.

The adaptability of this plant to marine installations may be judged from the following measurements, which show the compact design. When mounted on skids, lengths of which are 44¾ inches, the height of the apparatus from the bottom of the skid to the top of the vacuum feed is 29 inches; width (diameter of tank), 16 inches. When furnished unmounted and without gasoline (petrol)



Cross-Sectional Views of Compact Marine Lighting Plant

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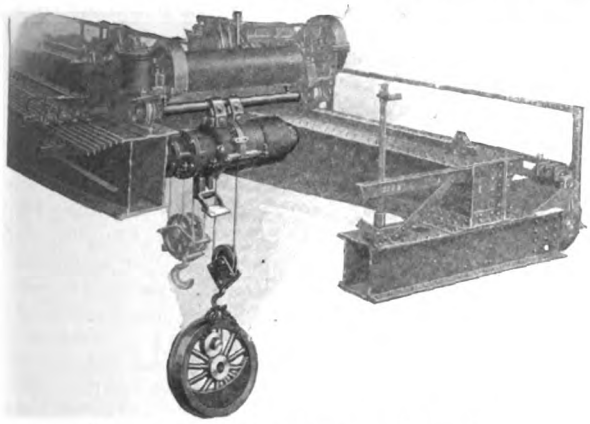
tank, as is the general practice for marine installations, the length, from the end of the shaft at the flywheel to the edge of the coil, is 22⅛ inches, and from the base of the plant to the spark plug 18⅛ inches. The width of the plant (diameter of flywheel) is 10 inches.

The plant is also furnished with circulating pump for marine installations. As may be noted from the illustrations, the coil is mounted on the end plate of the crank case, the breaker on the end of the cam shaft. The armature is the standard laminated drum type, hand-wound, with closed slots for retaining the windings.

Payne Auxiliary Hoist for Traveling Cranes

N. B. Payne & Company, 25 Church street, New York, is placing on the market a practical auxiliary hoist which may be attached to any standard overhead electric crane. The details of the apparatus are clearly shown in the accompanying illustration.

The manufacturers point out that the hoist does not take any more overhead room, does not require an extra trolley, does not shorten the travel of the trolley on the bridge, nor interfere with the accessibility of the main hoist. The average crane in a day's work handles a greater number of light loads than heavy. Since cranes for lifting heavy loads are slow-moving, their use results in a serious loss of time. These auxiliary hoists handle a light load of, say, three tons at a speed two to ten times as fast as the larger crane could possibly attain. The saving in power and the elimination of unnecessary labor are contributing factors.



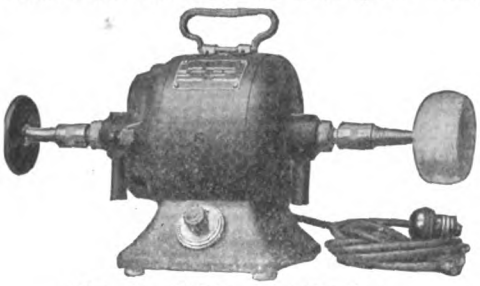
Payne Auxiliary Hoist for Traveling Cranes

By the application of this auxiliary attachment, any standard single-hoist electric traveling crane may be equipped with two lines for drop-bucket service. The auxiliary can be attached by the purchaser.

These standard auxiliary hoists are supplied in from 1- to 5-ton sizes. Larger special sizes, however, may be furnished for particular work. The control may be arranged from cage, floor or pulpit to suit the crane to which the apparatus is to be applied.

Motors for Polishing and Grinding

By the use of the polishing and grinding motors supplied by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., these operations are easily accomplished by simply snapping the switch to start the motor and applying the attachment to the surface for a few moments. The motor is always ready, and can be connected to any ordinary socket for use when grinding small parts.

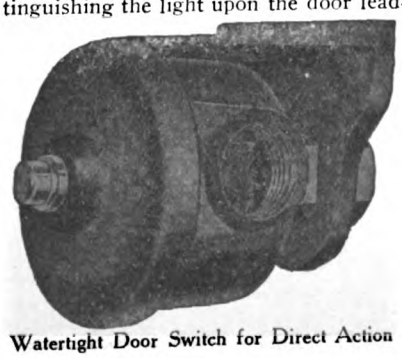


Motor for Polishing and Grinding

Marine Water-Tight Door Switches

On all vessels traversing the sea in war time it was found essential that the interiors be lighted adequately. It was also essential that the decks and exterior of the ship be submerged entirely in darkness, except as for such enclosed lights as are necessary for running.

To open the door from a passageway upon the deck, without at the same time putting out the light, would have risked transmitting a signal to a waiting submarine. The door switches which are illustrated here were designed, therefore, for the purpose of instantaneously extinguishing the light upon the door leading to the deck being opened, even slightly.



Watertight Door Switch for Direct Action

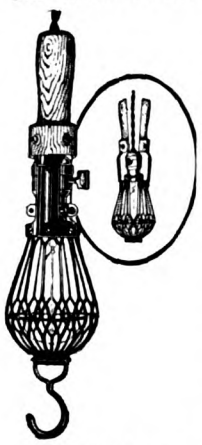
The devices are watertight, made rugged throughout in order to stand up under the marine service. The mechanisms are positive and quick in action; less than a quarter inch movement in the door actuates the switch and makes or breaks the circuit.

They are made in two types, termed direct acting and indirect acting. In the direct acting the plunger impinges directly against the door. In the indirect acting the door actuates a lever plunger protected by a spring against sudden slams or shocks. Both types are adjustable for any direction of conduit entrance, and may also be adjusted for varying widths of door frame.

They are manufactured by the Benjamin Electric Manufacturing Company, 806 West Washington Boulevard, Chicago, Ill.

Flexo Split Handle for Portable Lamp Guards

A special "Flexo" split handle has been put on the market by the Flexible Steel Lacing Company, of Chicago, Ill., which may be attached to the portable lamp guards manufactured by that company.

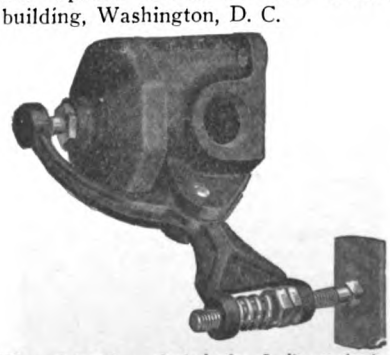


Adjustable Lamp Guard

The halves of the guards, including the handle itself, open wide from the hinge at the bottom, and can be instantly closed and locked around the switch at the end of any extension cord. The cord itself runs through the grooves in the handle.

National Merchant Marine Association Opens Washington Office

The National Merchant Marine Association, composed of men prominent in the shipbuilding and ship operation field, has opened offices at 1111 Munsey building, Washington, D. C.



Watertight Door Switch for Indirect Action

As has been previously noted this association has been formed to develop the possibilities of the American merchant marine. William Allen is now serving as acting secretary.

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Marine Construction News of the Month

Ships, Shipyards and Shipyard Improvements—Terminal Projects—Launchings—Government Contracts

NEWS OF SHIP CONTRACTS

The Skinner & Eddy Corporation, Seattle, Wash., has received a reinstatement on contracts to build 25 steel vessels for the Emergency Fleet Corporation.

The Norwegian-American Steamship Company, 8 Bridge street, New York, it is reported, has placed a contract for two modern freighters of 9,500 deadweight tons with Napier & Miller, Glasgow, Scotland.

The Wisconsin Shipbuilding & Navigation Company, offices 214 West Water street, Milwaukee, Wis., yards, Kewaunee, Wis., has received a contract to build two 1,000-ton freighters.

The Newport Shipbuilding Corporation, Newbern, N. C., has received a contract to build 9 concrete river steamers for the War Department.

It is reported that the Todd Dry Dock & Construction Corporation, Tacoma, Wash., will receive a reinstatement from the Government on twelve steel ships on which contracts were suspended as the result of the shipyard strike in Tacoma.

It is reported that Swan, Hunter & Wigman Richardson, Ltd., Wallsend-on-Tyne, England, has received a contract from the Cunard Line for the construction of a 600-foot passenger steamer with a deadweight of about 12,500 tons. The vessel is to be fitted with geared turbines.

The Bayles Shipyard, Inc., Port Jefferson, N. Y., has signed a contract to build a 1,200-ton deadweight single screw steel oil tanker "for American interests."

The Coastwise Shipbuilding Company, Baltimore, Md., has received a contract to build a wooden schooner for the Chesapeake & South American Transport Company, Baltimore, Md.

It is reported that the National Shipbuilding Corporation, 202 Canal Bank building New Orleans, La., has received a contract from the Pan-American Transportation Company to construct three river oil barges, and that the company has also been awarded the contract for building four self-propelled steel semi-oceangoing barges to be built for the Cuyamel Fruit Company.

The Nyack Shipbuilding Corporation, Nyack, N. Y., has received a contract to build an 18-foot sailing boat and a 20-foot motorboat, to be used at the lighthouse at Tompkinsville, Staten Island, N. Y. The former will cost $527 and the latter $1,303.

The Alabama Dry Docks & Shipbuilding Company, Mobile, Ala., has received a contract for repairing the 2,206-ton oil tanker *San Antonio*. The contract will probably aggregate about $100,000.

D. Murphy, Kingston, N. Y., has received a contract for building twelve covered barges, 103 feet by 33 feet by 9 feet, for the Edward J. Barton Lighterage Company, 1 Broadway, New York. No machinery will be installed on these boats.

The Carteret Ferry Corporation, Linoleumville, S. I., N. Y., is building two four-mast wooden schooners.

Installation of machinery on eight seagoing tugs being built by M. M. Davis & Sons, Solomons, Md., is being carried out by H. E. Crook Company, Baltimore, Md.

Sunde & d'Evers Company, Seattle, Wash., has received a contract for outfitting three four-mast sailing schooners now being built at the Cholberg shipyard, Victoria, B. C., for Captain H. C. Hansen, Portsgrund, Norway.

The Cape Cod Shipyard, Wareham, Mass., is building an 80-foot twin-screw wooden passenger vessel, which will be operated by gasoline motors. Frederick K. Lord, 120 Broadway, New York, is the designer.

The Concrete Ship Molding Company, Seattle, Wash., is building a full-rigged sailing vessel for private interests.

Three 500-ton wooden barges are being built by the Samuel Beskin Shipbuilding Company, Peekskill, N. Y.

The Howard Shipyards & Dock Company, Jeffersonville, Ind., with yards at Paducah, Ky., has received a contract to build 10 oil barges.

Probably the last cancellations of contracts for wood vessels were received on March 27 at Astoria, Ore., when contracts for nine vessels were canceled at the McEachern Ship Company, three at the Wilson Shipbuilding Company, and four at the George F. Rodgers & Company plants.

Bids Solicited on Battleships

According to a statement issued by Franklin D. Roosevelt, acting Secretary of the Navy, on April 4, proposals for the construction of two battleships, Nos. 53 and 54, will be received until May 21, 1919.

Fire Boat for Jacksonville

The city of Jacksonville, Fla., is about ready to purchase a fire boat. Construction details are not yet determined. J. Everts Merrill is secretary of the city commission.

NEW SHIPBUILDING PLANTS

Wisconsin Shipyard Receives Contracts

E. T. Thomas, president of the Wisconsin Shipbuilding & Navigation Corporation, with yards located at Kewaunee, Wis., and offices at 214 West Water street, Milwaukee, Wis., announces that the company has accepted an order for two 1,000-ton steel freight and passenger vessels of sixteen knots. These two ships, a part of ten ships forming a line between North and South America, are to be delivered in November 1919. The vessels are to be fabricated from materials prepared by outside shops.

Good headway is being made on the construction of the plant, a special feature of which is the adoption of the Thomas drydock system, approved by leading marine engineers as a practical and correct way of handling ships. By means of a cradle, ships to be repaired can be transferred to a shore dock. No actual repair work will be carried on while the ship is on the drydock.

New Western Shipbuilding Plant

The organization of the San Francisco Open Dry Dock Company, with a capitalization of $2,000,000, has been begun through the filing of articles of incorporation. The site of the plant is located between the army transport docks at Fort Mason and the exposition site. The new plant will include a wharf 58 by 1,100 feet, with two slips 200 feet wide, a floating drydock, composed of wood and concrete, of 8,000 tons, warehouses, office buildings and machine shops. W. H. Kearney, C. H. Kearney, F. P. Parker, J. W. Machado, A. T. Briggs, P. A. Breen and I. L. Steinman are the incorporators.

Contract Let for $2,000,000 Shipbuilding Plant

Norton, Bird & Whitman, Munsey building, Baltimore, Md., are completing the preliminary plans of a large ship repair works which they have been engaged to build at Spring Garden. The repair yard will consist of shipways, drydocks, plate, angle, foundry and machine shops, a general construction building, a warehouse, etc. The plant will be fully equipped, it is reported, to carry on repair and construction work on steel vessels. The initial cost of the plant will probably be about $2,000,000.

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New Ship Repair Shop at Wilmington, Del.

Simultaneously with the report of Charles Warner, chairman of the Board of Harbor Commissioners of Wilmington, Del., on the progress made for a new harbor and terminal for Wilmington, as the result of consultations on the project in Washington, is the announcement that a large ship repair plant will locate in Wilmington, provided the harbor project becomes a reality. The proposed plant would cost between $4,000,000 and $5,000,000, it was said.

New Ship Repair Shop

The Baltimore Marine & Iron Works, Inc., is the name of a corporation which has been established, with a capital of $50,000, at Clement and Woodall streets, Baltimore, Md., for the repair of ships and for the construction and repair of marine and stationary boilers. The company plans to build a machine and boiler shop.

Tampico to Have Shipbuilding Plant

A shipbuilding yard has been established at Tampico by the Laguna Transportation Company, which has built a shipway and installed machine shops and other necessary equipment. Mr. R. S. Dillman is in charge of the new department of the company, which intends, in addition to building and repairing barges and launches for its own use, to do general contract shipbuilding.

New Shipbuilding Enterprises

The Chicago Bridge & Iron Works, Washington Heights, Ill., is planning to build a steel barge plant on a five-acre site in South Chicago. Here, coaling barges 110 feet long and of 500 tons capacity will be built for the United States Navy.

McCay Brothers, Daytona, Fla., will erect a shipbuilding plant at West Palm Beach, Fla., to build wooden vessels 150 feet long, of five-foot draft. The plant will install woodworking machinery.

The Great Lakes & Ocean Transportation Company, Wilmington, Delaware, has been incorporated, with a capital of $2,000,000, to build and operate boats and to carry on a business as ship brokers.

The Deep Water Ship Company, Dover, Del., has been incorporated, with a capital of $100,000, for the building and operating of vessels.

A feature of the March record was the organization of three large drydock companies. The Clinton Dry Docks, Inc., was chartered in New York, with an authorized capital of $2,000,000; the Savannah Dry Dock & Repair Company, in Delaware, with an authorized capital of $1,500,000, and the Delaware Drydock & Shipbuilding Company, in the same State, at $1,000,000.

SHIPYARD EXTENSIONS

Lane Life Boat Company Enlarges Plant

The C. M. Lane Life Boat Company, 246 Huron street, Brooklyn, N. Y., has just completed a new factory building, with offices and garage additional, which will be utilized for wood work in connection with the present plant, which covers an area of more than 100 by 400 feet. The company is now equipped to furnish power lifeboats and the Engelhardt collapsible lifeboat, also metallic and wooden lifeboats on a larger scale.

Accessory Buildings

The Bethlehem Shipbuilding Corporation, Sparrow's Point, Md., is planning the erection of a two-story rivet storage shop to cost about $30,000.

The Simpson Dry Dock Company, East Boston, Mass., is planning to build a one-story brick machine shop.

The Union Iron Works Company, Norfolk, Va., it is reported, is in the market for new equipment.

The Atlantic Basin Iron Works, Summit avenue, Brooklyn, N. Y., is planning to build a one-story addition to its forge shop to cost about $45,000.

Hughes Foulkord Company, 1406 Commonwealth Building, Philadelphia, Pa., has entered the lowest bid for building a spar shop at Portsmouth, N. H., at $62,000.

$1,000,000 Drydock at Kingston

The Kingston Shipbuilding Company, Kingston, N. Y., is planning, with the co-operation of the Emergency Fleet Corporation, to build a 20,000-ton floating dry dock at that place to cost about $1,000,000.

Marine Railway for Astoria, Ore.

Thomas Bilyeu, manager of the Astoria Marine Iron Works, Astoria, Ore., has announced that the company will build a marine railway capable of handling ships up to 6,000 tons deadweight, to be built on the Young's Bay property under the direction of the United States Shipping Board. The new marine railway will cost about $500,000.

The company has acquired 500 acres of land on Young's Bay, it is reported, with a frontage of 12,000 feet, upon which will be erected a steel and iron-working plant.

Moore Shipbuilding Company Builds 12,000-Ton Drydock

The Moore Shipbuilding Company, Oakland, Cal., is about ready to construct a wooden floating drydock with a capacity of 12,000 tons. The dock will be composed of four pontoons. Contracts for the necessary dredging, piling, etc., are now being placed. The company also contemplates the construction of two marine railways, capable of docking vessels up to 5,000 tons capacity.

PORT IMPROVEMENTS

Astoria, Ore., Lets Terminal Contract

J. A. McEachern Company, Astoria, Ore., has received a contract to build a warehouse on Pier 1 of the port dock of Astoria, the price of which is $33,775. The Astoria Port Commission tentatively approved the plans for the construction of Pier 3 and warehouse. This pier will be 2,200 feet long and 300 feet wide. The estimated cost of the construction is $981,600. The complete harbor development will include eleven piers averaging 2,200 feet in length.

At present the development at Astoria represents $1,125,000. The total authorized expenditure is $3,128,300. Provision is made in these plans for a 15,000-ton drydock, to be located at the head of Slip 2.

Bids for Philadelphia Piers Announced

Bids were opened on March 27 for the construction of piers Nos. 82 and 84, South Delaware wharves, Philadelphia. Arthur McMullen Company, 149 Broadway, New York, entered the lowest bids, for pier No. 84, $898,000, for pier No. 82, $855,000. The work, covering the costs of dredging, filling, and other supplementary work, according to the bid of Arthur McMullen Company, amounts to $2,266,400.

Bids will be received in May for the construction of the 300-500-foot Penn Treaty pier by the Philadelphia Harbor Commission. G. W. Webster, Bourse Building, Philadelphia, Pa., is the engineer in charge of the work.

Seattle Piers Assured

Bids have been accepted by the National City Company, of New York and Seattle, Wash., for $500,000 worth of Seattle improvement bonds, which will insure the commencement of work on the new Smith Cove unit. This new pier will be equipped with the most modern freight and cargo-handling machinery. Preliminary dredging at the site has already been commenced by the Tacoma Dredging Company.

The Seattle Port Commission, Seattle, Wash., has authorized the purchase of a 35-ton electric crane from the Ohio Locomotive Crane Company for $25,766, with an additional cost of $2,959 for fitting the apparatus with an electric hoist magnet. The Northwest Bridge & Iron Company, Portland, Ore., was allotted the contract for building a 10,000-barrel steel tank, which is to be erected on the Smith Cove wharves.

Details of Charleston, S. C., Dry Dock

Although bids have not yet been solicited for the erection of the No. 2 drydock, which will be built under the supervision of the Bureau of Yards and

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Docks, Navy Department, Washington, D. C., the following details concerning the construction are now available.

The work involves extensive excavation work and dredging in the preparation of the site, installation of piping, erection of a bulkhead, cofferdam and other temporary structures, together with building the drydock proper, which will consist of 180,000 cubic yards, concrete, pump well, suction chamber, railroad tracks, crane tracks with supporting concrete construction, culverts and sluices, with hydraulically operated valves, keel blocks, bilge blocks, including slides with fitting capstans, and other construction work. About $3,500,000 will probably cover the cost of the construction.

Will Enlarge Mare Island Navy Yard

Although $2,500,000 is being expended in the development of Mare Island navy yard at present, the yard officials are planning a greater development of this base. In expectation of keeping one-half of the American fleet on the Pacific coast, appropriation of $1,700,000 has been asked for dredging and deepening of the channel at this yard as a preliminary step toward the enlargement.

Plan to Enlarge Bremerton Naval Base

The naval affairs committee of the House of Representatives, after their tour of the Bremerton naval base, Bremerton, Wash., reported that they believed an expenditure of at least $8,000,000 should be utilized to develop the Bremerton naval base to its fullest capacity. Of this amount $400,000 has already been appropriated. As soon as the extension work is begun at the yards, local officials plan the building of a 400-foot wharf, to provide for the unloading of scows, a big warehouse for freight and small bunkers for coal.

$1,000,000 Oil Terminal

The Texas Oil Company is planning to build a large oil plant at Chotaw Point, Mobile. Piers will be built for the accommodation of oil barges, which will be supplied with adequate bunker facilities and sufficient pipe lines. The holding tanks will have a capacity of 64,000 barrels each. About $1,000,000 will be expended in the development.

The Standard Oil Company, Baltimore, Md., is planning to build a six-story concrete warehouse on the west side of Pier 2, at Pratt street, to cost about $200,000.

Plan $3,500,000 Drydock at Vancouver

A Seattle concern has submitted a proposal to the Provincial Government of British Columbia, at Victoria, B. C., for the construction of a steel drydock, of 25,000 tons lifting capacity, on the condition that the Province should guarantee the principal and interest of the bonds issued up to 55 percent of the cost, the Provincial Government to hold the first lien on the property. The estimated cost of the drydock would be $3,500,000.

The Dominion Government under its drydock subsidy guarantees for thirty-five years payment annually of 4½ percent of the actual cost of construction. In the event of failure on the part of the company which proposes the construction, the Provincial Government would in that case own the property for 55 percent of its cost, and the Dominion Government's subsidy would still be operative. As yet no final action has been taken.

Gantry Cranes for Providence

The city of Providence, R. I., is contemplating the installation of efficient cargo-handling machinery at that port. City Engineer Bronsdon has been instructed to draw plans for the installation of six and eight 2-ton gantry cranes on the municipal dock.

Terminal Appropriations

A bill was signed on April 7 providing $6,800,000 for the development of terminal facilities along the New York State barge canal. The Assembly Rules Committee also recommended the bill appropriating $950,000 for the construction of terminals at Newburgh, Kingston, Poughkeepsie and Yonkers.

The city of Portland, Ore., is about to issue $1,250,000 of harbor development bonds, to be expended in the further development of the St. John's Municipal Terminal.

An appropriation for $830,000 for the improvement of Los Angeles and Long Beach harbors has been approved by the ways and means committee of the California State Legislature.

The city of New Orleans is spending $14,000,000 in the improvement of municipal docks. At present over 10,000 men are employed in the work.

The city of Orange, Tex., is about to build wharves and docks which will cost $150,000.

The city of Portland, Ore., is still working on a project to build a 12,000-ton drydock. It is now estimated that this structure will cost about $1,250,000.

Government Contracts Awarded

The Bureau of Yards and Docks, Navy Department, Washington, D. C., has awarded the following contracts: The construction of a wet basin at Pensacola, Fla., to the Newport Engineering & Contracting Company, Newport News, Va., for $47,100; the installation of an electric traveling crane at the storage shed, Boston, Mass., to the Bedford Foundry & Machinery Company, Bedford, Ind., for $8,980.

Contract has been let to Harry Cotton for the construction of a $30,000 concrete dock at Fort Flagler.

The Bureau of Yards and Docks, Navy Department, Washington, D. C., has let a contract to Havery & Company, 517 South Los Angeles street, Los Angeles, Cal., for building a gasoline storage and supply system at San Diego, Cal., to cost $15,875.

The Aberthaw Construction Company, Boston, Mass., has received a contract to build twelve storage buildings at Aberdeen, Md., at the cost of $450,000.

W. L. Miller & Co., 171 Alford street, Boston, Mass., has received a contract for building a concrete quay wall and fill at Newport, R. I., to cost $133,739.

Contract has been let to E. S. Downs Company, 9 Campbell street, Newark, N. J., for electrical work at Ward's Island, N. Y., to cost $3,640.

C. L. Creelman has been awarded the contract for making a 250-foot addition to the Tracy street terminal, Seattle, Wash.; $30,989 is the amount of the expenditure. It has been recommended that the bid of Wellman-Seaver-Morgan Company to supply a gantry crane for Smith-Cove terminal for $87,700 be accepted.

Contract has been let by the Bureau of Yards & Docks, Navy Department, Washington, D. C., for the construction of a wood pier at Norfolk, Va., to the Boyle-Robertson Construction Company, Washington, D. C., to cost $156,207.

Bids have been opened by the Bureau of Yards and Docks, Navy Department, Washington, D. C., for the building of a water tank at Newport, R. I. The Pittsburgh-Des Moines Steel Company, 959 Munsey building, Washington, D. C., entered the lowest bid of $11,760.

The National Contract Company, Evansville, Ind., has received a contract to build lock and dam No. 30 on the Ohio River. The work will cost $636,446.39. The Dravo Construction Company, Pittsburgh, Pa., was the next highest bidder.

The Bureau of Yards and Docks, Navy Department, Washington, D. C., has awarded the following contracts: For the installation of turbo-alternators at Washington, D. C., to Baker-Dunbar-Allen Company, Philadelphia, Pa., $10,180; for the installation of coal and ash-handling equipment at New York to the Specialty Engineering Company, Philadelphia, Pa., $24,825.

Industrial Piers

The Denero Realty & Manufacturing Company, 6900 South Broadway, St. Louis, Mo., is planning to build a dock and an addition to cost about $150,000. C. E. Hayden, 3400 Maury avenue, St. Louis, Mo., is in charge of the work.

The Eastern Wisconsin Electric Company, 428 North Eighth street, Manitowoc, Wis., plans to build a modern dock to cost about $150,000. The Kelsey Brewer Company, La Crosse, Wis., is in charge of the work.

The Huntsville Gin & Wharf Company, Huntsville, Tex., has let a contract to W. H. Randolph for the construction of a cotton wharf and accessory buildings, to cost about $30,000.

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Future Government Work

The Bureau of Yards and Docks, Navy Department, Washington, D. C., may be addressed concerning specification for the power plant improvements at Pearl Harbor, T. H., to cost about $80,000.

Bids were opened on April 20 by the Lighthouse Superintendent, Boston, Mass., at the Lighthouse Depot, Chelsea, Mass., for building a new sea wall and wharf.

The United States Engineer Office, Philadelphia, Pa., will receive proposals until May 8 for the construction of a marine railway at Fort Mifflin.

The Bureau of Yards and Docks, Navy Department, Washington, D. C., has invited bids on the building of ten buildings at Yorktown, Va., at an estimated cost of $177,500, also filling and dredging at Norfolk, Va., to cost about $500,000.

Louis Nixon, superintendent of Public Works, Albany, N. Y., will receive bids until April 29 for the building of a barge terminal freight shed on Pier 93, West Fifty-third street, New York. About $53,969 is involved in the contract.

The Bureau of Yards and Docks, Navy Department, Wash., D. C., is planning to install reciprocating air compressors at the Bremerton naval base, Washington, to cost about $62,000.

The Bureau of Yards and Docks, Navy Department, Washington, D. C., invites proposals on the following projects: Installation of six electric bridge cranes at the extension of the machine shop and foundry, Boston Navy Yard, $175,000; installation of six I-beam electric traveling cranes at the Torpedo Assembling Plant, Alexandria, Va., $10,800; building a concrete quay wall and fill at the Naval Training Station, Newport, R. I., $100,000.

The three-story building to be erected by the Bureau of Yards and Docks at Annapolis, Md., will be built by Levering & Garrigues, New York, who have submitted the lowest bid of $800,000. The building is to be 60 by 370 feet.

The Country's Drydock Capacity Increasing

The fifth section of the drydock which is being built for the Skinner & Eddy Shipbuilding Company, Seattle, Wash., has been completed by the Port Blakely Mill Company. This unit gives the plant the largest unit drydock in the Northwest, since it will be able to accommodate 15,000 tons or more when ready for operation.

The fourth section of the drydock of the Morse Dry Dock & Repair Company, Brooklyn, N. Y., was floated on April 2. The six-section floating drydock will be 19,000 tons, and will accommodate ships of 30,000 tons and up to 750 feet long.

The George Leary Construction Company, which recently completed a 1,000-foot drydock at the Norfolk Navy Yard, is now building two 400-foot docks at the same location. One of these is about 75 percent complete.

The Jahncke Company, New Orleans, La., announces favorable progress in the building of the 10,000-ton drydock on the Industrial Canal. The use of this drydock and the 16,000-ton drydock at the Algiers naval station will enable New Orleans to handle the largest vessels, and will greatly relieve the overcrowded repair plants on the Gulf.

Five of the seven pontoons being fabricated by the Texas Carnegie Steel Association, Galveston, Tex., are about completed. This 10,000-ton floating dry dock is being constructed for the Galveston Dry Dock and Construction Company, Galveston, Tex.

The Valk & Murdock Dry Dock Company, Charleston, S. C., has received its first repair work on its new drydock, taking on a 4,300-ton Swedish vessel. This is the largest drydock south of Cape Hatteras. Only four sections are now in operation; when the six sections are installed the drydock lifting capacity will be 7,500 tons, and it can accommodate vessels 450 feet in length.

Pearl Harbor Dry Dock Completed

A 1,029-foot floating drydock has recently been completed at Pearl Harbor, Honolulu, T. H. The construction, which has involved the expenditure of about $4,500,000, was under the supervision of the Bureau of Yards and Docks, Navy Department. Since the cofferdam method of construction was not practical, the entire dock was constructed in sixteen sections on floating drydocks. The dock will be ready to receive warships in about sixty days. Work was begun upon the construction by the San Francisco Bridge Company in July, 1909.

New $4,000,000 Drydock at Quincy Point, Mass.

S. W. Wakeman, manager of the Fore River plant of the Bethlehem Shipbuilding Corporation, Bethlehem, Pa., is urging the construction of a floating drydock at Quincy Point, Mass. Roughly, the new construction will cost between $4,000,000 and $5,000,000. The plan calls for a sectional drydock with accommodations for two 500-foot ships of 10,000 tons each, or one 18,000-ton ship averaging 700 feet in length.

Maritime Works Destroyed

Nearly half the maritime works of Monfalcone, sixteen miles northwest of Triest, have been destroyed by fire.

Superdreadnought Tennessee Launched April 30

The superdreadnought *Tennessee*, which is under construction at the New York Navy Yard, was launched on April 30.

GENERAL SHIPYARD NEWS

Output of the American Ship-Building Company

On March 26 the directors of the American Shipbuilding Company, Cleveland, O., declared a regular quarterly dividend of 1¾ percent, and an extra cash dividend of 2¼ percent on the common stock. The American Shipbuilding Company, at its six Lake yards, has orders for 111 steamers, 45 of which will be completed and ready to leave for the coast when navigation opens.

Bethlehem Steel Corporation Plans Further Enlargement of Sparrow's Point Plant

The April report of the Bethlehem Steel Corporation, which will be presented to stockholders during the month, states that during this year about $20,000,000 will be spent at the Sparrow's Point steel plant.

When this industrial development is completed an investment of $50,000,000 will be made productive. The corporation will be in a position to produce an annual capacity of over three million tons of steel ingots, and since the development of shipbuilding plants has kept pace with the steel plants in capacity and equipment, they are prepared to build vessels of any type or size.

The Bethlehem Shipbuilding Corporation's plants delivered 625,000 deadweight tons of merchant shipping from the date war was declared to the close of 1918, which represents about 22 percent of the output of the entire country during this period. This tonnage does not include 26 torpedo boat destroyers and 16 submarines delivered during 1918, or 36 destroyers launched and fitted out during 1919.

New York Shipbuilding Corporation's Report Shows Growth

The annual report of the New York Shipbuilding Corporation, Camden, N. J., was made public on April 7.

Fifteen steamers were completed during the year, aggregating 120,000 tons deadweight. Seven naval vessels were launched during the year, and thirteen were on the ways and ten more in the shops on December 31.

The financial statement of the company shows a gross profit of $2,624,647, compared with $1,167,404 in 1917.

Standifer Plant at Vancouver to Be Permanent

James McKinlay, who was general manager of the G. M. Standifer Construction Corporation's shipyard on the Columbia River, has been appointed yard manager at the Vancouver plant. J. A. Sim, who planned the Vancouver yards, continues as general manager. This is in line with the company's plan to establish the Vancouver yards on a permanent basis.

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Expenditure at Philadelphia Navy Yard

Details of the enlargement of the Philadelphia Navy Yard, which will entail the expenditure of about $20,000,000, are given out as follows: The building of a 1,064-foot drydock, $5,000,000; the building of two new 900-foot ways, a large structural machine shop, and smaller pattern and machine shops, $3,000,000; the construction of the naval aircraft building, $5,000,000. The daily pay roll of the yard amounts to $51,000.

New York Shipbuilding Company Holds Contract for Nine 13,000-Ton Vessels

The New York Shipbuilding Corporation, Camden, N. J., now employing 14,000 workers, is building hulls Nos. 240, 241 and 242, which are the largest vessels under construction in the United States. The length of these combination passenger and cargo vessels is 535 feet, with 72-foot beam and a molded depth of 50 feet. The allowable draft is 30 feet 6 inches. The vessels, which have a displacement of 21,000 tons and a deadweight tonnage of 13,000 tons, will be equipped with twin-screw propellers, driven by two Westinghouse double reduction geared turbines, developing 12,000 horsepower. Steam is generated by batteries of Babcock & Wilcox boilers of the watertube type fired by oil fuel.

When in operation the vessels will accommodate 500 cabin passengers, and as many steerage passengers as may be desired up to 1,000. In addition 9,000 tons of cargo can be handled. For present use, however, as transports, the vessels will accommodate 3,500 troops, including regular quota of officers, military equipment and stores. The company also holds a contract for six more vessels of the same type, work upon which has not yet been begun.

Layton Company Completes Nine Government Barges

The B. Layton Company, Quincy, Ill., has just completed a Government contract for the building of nine barges. These barges, which are 120 feet long, 30 feet wide, 8 feet deep, and have a capacity of 250 tons each, will be utilized by the Navy Department in coaling service on the Atlantic seaboard.

Construction Work on Concrete Tankers

The Pacific Marine & Construction Company, San Diego, Cal., will be ready on May 1 to pour the concrete into the molds of the 7,500-ton oil tankers being built at those yards. Shipments of larsite are being received at the yards. The total quantity of concrete used for one tanker is 2,700 cubic yards. The new clay aggregate weighs 110 pounds to the cubic foot, as against 150 pounds for ordinary concrete. This material gives 4,000 tons as the weight of the concrete in the vessel,

Eastern Shore Shipbuilding Corporation's Plant for Sale

The shipyard of the Eastern Shore Shipbuilding Corporation, with offices at 2 Rector street, New York, and plant at Sharptown, Md., as noticed in the NEWS SUPPLEMENT of March 28, will be subject to a receiver's sale on May 15 at 10 A. M.

The plant, which is in full operation by the receivers, has seven vessels under construction. Within the last eighteen months the entire plant has been remodeled and up-to-date machinery and equipment installed. Six shipways are provided, with a capacity to build vessels of 6,000 tons; the ways front on deep water.

Shipyards Expanding

The Chester Shipbuilding Company, Chester, Pa., has commenced the erection of the one-story addition at Front and Kerlin streets. The structure will be about 37 by 140 feet, and will be equipped for assembling operations, providing for increased operations in this department of the plant.

The Biloxi Dry Dock & Shipbuilding Company, Pascagoula, Miss., is now giving employment to close to 175 men at its local yards, with payroll aggregating about $25,000 per month. The company is specializing in the construction of wooden vessels. The plant is being devoted to the production of a number of three-masted wooden schooners about 147 feet over all in length.

The Greenport Basin & Construction Company, Greenport, L. I., is operating its local shipbuilding plant, known as the Liberty Yard, for the construction of a number of barges for the Government. The company has a contract for seven boats of this type, each about 110 feet long, the first of which has now been launched. In the coming months a portion of the yard capacity will be devoted to overhauling and repair work, to include a number of submarine chasers, and construction of an entire new hull for a large steamer.

The Ambursen Construction Company, 61 Broadway, New York, N. Y., will soon complete the first concrete barge at its shipyard at Little Ferry, N. J., for the Navy Department. The company has a contract for a number of such boats for the Government, each about 36 feet wide and 125 feet long. It is planned to inaugurate construction on a second such barge at an early date.

Rapid progress is reported in the construction of the new marine railway being located at the naval coaling station at La Playa, Cal., by the Ross Construction Company. The railway will probably be completed by January 1, 1920. It will cost about $250,000.

The Bayles Shipyard, Inc., Port Jefferson, L. I., is now engaged in the construction of four steel vessels for the Government, consisting of two boats of about 5,000 tons capacity, and two ocean-going tugs. Following the completion of these vessels, the yard will be used for the building of steel vessels for private interests, with plans under way for the construction of an oil tank vessel of about 1,200 tons capacity.

The Johnson Iron Works, New Orleans, Louisiana, is constructing a steel transfer barge, to be used in connection with the towboats and barges which are being built to carry coal and freight on the Warrior Barge Canal. This barge will be equipped with fast-hauling devices, and will move under its own power to any wharf or steamship pier within New Orleans harbor to effect rapid transfer of freight.

George Gordon Crawford, president of the Chickasaw Shipbuilding Company, Mobile, Ala., reports that the keel for the second 9,600-ton steamer will be laid as soon as the steel is fabricated. Eight ships will be under construction as soon as the ways are ready, four ways having already been completed.

A. H. M'Leod & Company, Jacksonville, Fla., which has been handling large contracts for the United States Shipping Board for awning, tent work, ship rigging, etc., is now in a position to take on new contracts. The plants at Mobile and Pensacola were also utilized during the war for the Shipping Board orders.

According to an announcement of Naval Constructor Henry N. Gleason, head of the hull department, Mare Island, Cal., the cost of the hull of the battleship *California*, which is being built at the Mare Island yards, will be from $500,000 to $1,000,000 less than the contract price. This cost, it is reported, is considerably less than the cost of the *Tennessee*, which is being built at the New York navy yard.

Pusey & Jones Receivership Denied

An application for a receivership for the Pusey & Jones Company, with shipyards at Gloucester, N. J., and Wilmington, Del., was filed in the Federal Court on April 18 by Bleakly Bros., Camden, N. J.,

When the issue was brought up for discussion before Vice-Chancellor Lane, Newark, N. J., on April 22, the application of the Eastern Trucking Company, one of the creditors, for the appointment of a receivership was denied.

An officer of the company is reported as saying, "From our standpoint the Emergency Fleet Corporation is at fault. The corporation has not been willing to advance funds on materials until they are actually put into the ships."

Receivers for Groton Iron Works

P. Leroy Harwood, of New London, Conn., and Frederick Congdon, of Boston, Mass., have been confirmed as permanent receivers for the Groton Iron Works, Groton, Conn.

The defendant, a subsidiary of the United States Steamship Company, 50 Broad street, New York, is indebted to the latter to the extent of $800,000.

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RECENT LAUNCHINGS

The oil tanker *Romulus*, which is being constructed by the Bethlehem Shipbuilding Corporation, at its Harlan plant, Wilmington, Del., for the Vacuum Oil Company, has been launched.

The American International Shipbuilding Corporation, Hog Island, Pa., launched the vessel *Schoodic*, under construction for the Emergency Fleet Corporation, on March 29.

The Northwest Steel Company, Portland, Ore., launched the 8,800-ton cargo vessel *West Celeron*, which it is building for the Emergency Fleet Corporation, on March 28.

The Adams Shipbuilding Company, East Boothbay, Maine, has launched the tug *Clara H. Doane*, which is being built for Crowell & Thurlow, Boston, Mass.

The Baltimore Dry Docks and Shipbuilding Company, Baltimore, Md., launched the unnamed hull No. 92 on March 29. The vessel is one of the cargo steamers being constructed for the Emergency Fleet Corporation.

The Greenport Basin & Construction Company, Greenport, Long Island, N. Y., has recently launched its seventh 1,200-ton barge for the Government. The company is also rebuilding the fishing steamer *Quickstep* at a cost of $85,000.

The Gulf Shipbuilding Company, Mobile, Ala., launched the four-mast schooner *Ville de Dixmude*, of 2,500 tons, on March 15.

The sixth vessel, the *Clio*, built by the Pacific American Fisheries, South Bellingham, Washington, was launched on March 22. The *Clodia*, the last vessel to be built for the United States Shipping Board by that company, was launched on March 31.

The ocean-going tug *Basswood* was launched on April 5 at the Bayles Shipyard, Inc., Port Jefferson, L. I. This is the first steel vessel to be launched at a Port Jefferson yard.

The French trawler *Mondoir* was launched at the Savannah yards of the Foundation Company, 233 Broadway, New York, on March 26.

The Biloxi Dry Dock & Shipbuilding Company launched the schooner *Gabriella*, at Biloxi, Miss., on March 29.

The merchant vessel *Delungra*, of 5,000 tons, the first vessel to be constructed by the Australian Government under the commonwealth shipbuilding scheme, was launched on March 28 at Walsh island.

The steamer *West Cavanal* was launched by the Southwestern Shipbuilding Company, San Pedro, Cal., on March 20.

The city fire boat *Archie J. Ely* was launched on March 18 from the plant of the Marine Equipment Company, Los Angeles, Cal.

The Pacific Coast Shipbuilding Company, Suisun Bay, Cal., launched the second of ten 9,400-ton deadweight steel cargo carriers which the company is building for the Shipping Board on March 30. The vessel was christened the *Consumet*.

Percy & Small, Inc., Bath, Me., launched on March 30 the five-masted iron strapped wooden schooner *Joseph S. Zeman*, a 3,200-ton vessel which the company is building for David Cohen & Company, Inc., 29 Broadway, New York.

The merchant vessel *Louis Luckenback* was launched on March 30 at the Fore River plant of the Bethlehem Shipbuilding Corporation, Quincy, Mass. The *Luckenback* is of 12,000 tons capacity, 537 feet in length and has the distinction of being the biggest merchant vessel ever launched in this country.

Two steel freighters, the *Knoxville* and *Louisville Bridge*, were launched on March 27 at the yards of the Submarine Boat Corporation, Newark Bay, Newark, N. J. The *Anniston* and *Chattanooga*, 5,500-ton cargo vessels, were launched on March 30, and the *Montgomery* on March 31.

The Submarine Boat Corporation, Port Newark, N. J., has launched the thirty-sixth steel vessel, *St. Augustine*, at the yard.

The Federal Shipbuilding Company, Kearny, N. J., launched the vessels *Donora* and *Waukegan* on March 31.

On March 18, David & William Henderson & Company, Ltd., Partick, Glasgow, launched the 400-foot steel screw steamer *Tremorvah*, which it is building for the Hain Steamship Company, St. Ives, Cornwall.

On March 29 three steel vessels were launched in Seattle, Wash.—one 8,800-ton steamship *West Hembrie*, by J. F. Duthie & Company; one 9,600-ton steamship *Edgmour*, by the Skinner & Eddy Company, and one 8,000-ton steamer *West Irma*, by the Ames Shipbuilding & Dry Dock Company.

One of the large freighters, the *Waukau*, was launched by the Merchant Shipbuilding Company, Bristol, Pa., on March 31. Unfortunately the breaking of the scaffold caused the death of several spectators.

The Housatonic Shipbuilding Company, Stratford, Conn., launched the 3,500-ton wooden ship *Isto* on April 3.

The Tacoma Shipbuilding Company, Tacoma, Wash., launched the 3,500-ton Ferris type wooden steamer *Fort Jackson* on March 27.

The Coos Bay Shipbuilding Company, Marshfield, Ore., launched the steamer *Pamunkey* on March 26.

The Moore Shipbuilding Company, Oakland, Cal., launched the 9,400-ton freighter *Cotati* and the 10,000-ton oil tanker *Imlay* on March 30.

The Richard T. Green Shipyards, Chelsea, Mass., has launched the 2,000-ton capacity barge *Nahant*, which it is building for the United States Shipping Board.

Grays Harbor Motorship Corporation, Aberdeen, Wash., launched the 4,000-ton twin-screw steamer *Mannahocking* on April 1 for the Emergency Fleet Corporation.

The Columbia River Shipbuilding Corporation, Portland, Ore., launched the steel ship *West Tonate* on April 2.

The Stockton Yards, Inc., Stockton Springs, Me., launched on April 2 the four-masted schooner *A. Ernest Mills*, which it is building for Crowell & Thurlow, Boston.

On April 5, the Wallace Shipyards launched the 4,300-ton vessel *Canadian Volunteers*, which is being built for the Imperial Munitions Board. The yards will lay keels for vessels of 5,100 tons in the future.

The Allen Shipbuilding Company, Seattle, Wash., launched the *Ahmik* on April 4. The vessel was originally designed for the installation of Machinery, but has been converted into a barge.

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., launched the steamer *Calvert* on April 5.

The Seattle North Pacific Shipbuilding Company, Seattle, Wash., launched the 9,400-ton steamship *Osaqumsick* on April 5.

The Mobile Shipbuilding Company, Mobile, Ala., launched the 3,500-ton composite ship *Oyaka* on April 5.

The twenty-second ship, *Startia*, was launched at the shipyards of the American International Corporation, Hog Island, Pa., on April 5.

The launching of the steamship *Worcester*, by the Groton Iron Works, Groton, Conn., occurred on April 5.

The twenty-first ship, the *Seekonk*, was launched on April 5 at the Hog Island yard of the American International Shipbuilding Corporation.

The American Shipbuilding Company, Brunswick, Ga., launched the 3,500-ton steamship *Bridgewater* on April 5.

The Bath Iron Works, Ltd., Bath, Me., launched the destroyer *Aaron Ward* on April 10.

The Traylor Shipbuilding Corporation, Cornwells Heights, Pa., launched the last 3,000-ton cargo carrier, *Seyton*, which it is building for the United States Shipping Board, on April 10.

The Bethlehem Shipbuilding Corporation, Ltd., Quincy, Mass., launched the destroyer *Morris* on April 12.

Oscar Daniels Company, Tampa, Fla., launched the 9,600-ton steamship *Wilscox* at Tampa, Fla., on April 19.

The Meacham & Babcock Shipbuilding Company, Seattle, Wash., launched the barge *Cardia* on April 10.

The Foundation Company, 233 Broadway, New York, launched the 3,000-ton steamer *Mulhouse* at their Victoria, B. C., yards on April 10.

The Northwest Steel Company, Portland, Ore., launched the 8,800-ton vessel *West Chana* on April 12.

The Buffalo Dry Dock Company, Buffalo, N. Y., launched the steamer *Lake Fugard* on April 12. The vessel had all her machinery, boilers and superstructure, aboard and in place at the time of the launching.

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PERSONALS

Commander M. E. Reed, U. S. Navy, who has served as head of the Machinery Division of the Bremerton Navy Yard, has been ordered to Mare Island, Cal. Commander A. T. Church U. S. Navy, will succeed him at Bremerton.

A. A. Corey, general superintendent of the Homestead plant of the Carnegie Steel Company, has resigned to become president of the Cambria Steel Company, and vice-president of the Midvale Steel & Ordnance Company. J. S. Oursler will succeed him at the Homestead plant.

P. A. S. Franklin, president of the International Mercantile Marine Company, has left for Europe.

William M. Brittain, secretary of the American Steamship Association, has left for Europe in an advisory capacity for the United States Shipping Board.

James V. Converse has been appointed temporary secretary of the Shipping Board, to fill the place left vacant by the resignation of Lester Sisler.

Captain W. M. Hunt has been named marine superintendent of the Hampton Roads district of the United States Shipping Board.

M. Scarth Stevenson, Molsons Bank, Montreal, and Chandler M. Wood, president of the Metropolitan Trust Company, Boston, Mass., have been elected directors of the National Shipbuilding Corporation, Camden, N. J.

Henry Lysholm, consulting engineer and naval architect, Stock Exchange Building, Philadelphia, Pa., has been engaged by the New York Shipbuilding Corporation, Camden, N. J., to expedite the building of the destroyers, contracts for which have been awarded to this company by the Navy Department.

A. H. Lawton, of Savannah, Ga., has been elected president of the Ocean Steamship Company, to succeed William H. Pleasants, of New York, who died March 18.

The Virginia Shipbuilding Corporation, Alexandria, Va., announces the resignation of Robert L. Lake, purchase and traffic manager, who resigns to take up his private business affairs.

John F. Blain, formerly district manager of the United States Shipping Board Emergency Fleet Corporation, has opened offices at 453 Coleman Building, Seattle, Wash., and announces that his services are available as agent, owner's representative or surveyor of any floating property, for account of owners, shippers or underwriters. Associated with him is a competent marine engineer familiar with survey work in connection with engines and boilers. Cable address, Blainco, Seattle.

At the resignation of Fred G. Ballin, president of the Pacific Marine Iron Works, John L. Jennings was elected president of the plant, with Joseph Supple, vice-president, and Arthur Langguth, secretary. Edward G. Gordon, of the machinery firm of Gordon & Finbeiner,

OBITUARY

Marshall Ten Broeck Davidson, president of the M. T. Davidson Company, steam pump manufacturers, located at 154 Nassau street, New York, died on April 10, at the age of 82. In 1857 he began work in a marine engineering machine shop, and later went to sea as an assistant engineer on ocean steamships. During the Civil War he became chief engineer of an army transport, building at Wilmington, Del., superintending the construction and installation of its machinery. Later he became chief engineer in the Revenue Cutter Service. At the close of the war he began building up the Davidson steam pump and pump engine business. During the present war his company has equipped United States battleships and destroyers.

Frederick Weber, of F. Weber & Company, 1125 Chestnut street, Philadelphia, Pa., died on March 18, 1919. Mr. Weber had been actively connected with the business for over fifty years.

Captain William Dixon Burnham, a director of the American-Hawaiian Steamship Company and prominent in maritime circles, died on March 28 at his home in Port Chester, N. Y., aged 74.

Robert Edmund Twohy, vice-president of Twohy Brothers, interested in the Seattle Northern Pacific Shipbuilding Company, Seattle, Wash., and the Pacific Car & Foundry Company, died in San Francisco on March 22.

Barry O. Jones, secretary and director of the Bethlehem Steel Corporation and the Bethlehem Shipbuilding Corporation, Ltd., died on April 3.

William J. Galbraith, builder and superintendent of the New Orleans yards of the Foundation Company, 233 Broadway, New York, recently died at his home in Montreal, Canada.

Side Launching of the *Cushnoc* at the Yards of the Pensacola Shipbuilding Company, Pensacola, Fla., on March 15

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